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73 EASTING:
LESSONS LEARNED FROM DESERT STORM
VIA
ADVANCED DISTRIBUTED SIMULATION TECHNOLOGY

Proceedings of a Conference
27-29 August 1991
Alexandria, Virginia

Jesse Orlansky
Jack Thorpe, Colonel, USAF
Editors

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The Battle of 73 Easting, named after the map coordinates of its location, occurred on the second day of the war against Iraq. The mission of the Second Armored Cavalry Regiment, moving easterly as advance scouts, was to find and fix the Tawakalna Division of the Iraqi Republican Guard so that the VII Corps could engage and overcome the main Iraqi forces who were retreating to the north. Weather conditions restricted visibility and close air support. Both sides were surprised when Troops Eagle, Ghost, and Iron, outnumbered three-to-one, encountered and destroyed a heavy Iraqi brigade in a defensive posture. A great amount of detailed information about this battle was collected by walking the battlefield, interviewing the participants, and reviewing all available records including radio communications during the battle. These data were used to re-create the events in distributed simulation (i.e., using "SIMNET" technology); the product, a "moving picture" permits observers to review what actually happened at any moment from any position or vehicle on any side of the battle. No previous battle has been recorded in greater detail or can be re-created dynamically for study, review and "what-if" analyses.

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LTIC QUALITY INSPECTED 5

Jesse Orlansky
Jack Thorpe, Colonel, USAF
Editors

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April 1992

IDA

INSTITUTE FOR DEFENSE ANALYSES

FOREWORD

The Battle of 73 Easting, fought in Iraq on 26 February 1991, was quickly recognized to be a classic encounter between modern armored forces. A prompt decision was made to record the events of this battle in great detail and to re-create them using distributed simulation technology for subsequent study and analysis. The purpose of the conference on 73 Easting, described in this document, was to report on the progress achieved to date on this innovative effort.

Many people, in addition to the speakers, contributed to the success of the conference. The editors wish to acknowledge, in particular, the contributions of Jill M. Avery, Robert L. Clover, L. Neale Cosby, Ulf Helgesson, Grant E. Shackelford, Danet J. Trivette, and Christopher Turrell.

The conference describes a new way of capturing, organizing, and representing a large amount of detailed information about an actual battle. The officers and men of the Second Armored Cavalry Regiment fought that battle. We express our utmost admiration and respect for the men who did what had to be done at 73 Easting in Iraq on the second day of Desert Storm.

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Institute for Defense Analyses
Alexandria, VA

--73 EASTING--

MONDAY, 27 AUGUST 1991

--73 EASTING--

INTRODUCTORY COMMENTS

Colonel Jack Thorpe, USAF
Defense Advanced Research Projects Agency

COLONEL JACK THORPE, USAF

I am Jack Thorpe, Special Assistant to the Director of the Defense Advanced Research Projects Agency for Simulation. I'd like to welcome you to a working conference on applying a unique simulation technology to a real world event. We will attempt to understand how to manipulate that technology to capture actual events in history, as accurately as possible, and in a form that is useful.

This conference has been organized by one of four co-sponsors, the Institute for Defense Analyses. The co-sponsors are the Defense Advanced Research Projects Agency, the Institute for Defense Analyses, the Office of Military History of the Army, and the Engineer Topographic Laboratory at Fort Belvoir.

I'd like to spend a minute or two telling you about that technology because you will see it off and on, so just by way of orientation, let me tell you a little bit about what it is. There is a planview display. This is the big center screen. It will be at different levels of resolution in the course of the conference. The presenters who use it will explain what grid you're seeing, whether it's a kilometer grid, or 10 kilometer, so that you have a sense of orientation. The grid will appear on the planview display. Icons of the vehicles that are the subject of the simulation, tanks, aircraft, helicopters, personnel carriers, what-have-you, won't show up until the simulation actually begins. Then you will see an icon. If you look very closely and if each icon has been exploded (zoomed in on), you will be able to see the orientation of that combat platform and any articulated parts, such as its turret and where the gun is heading. There's a slight deception that you need to be aware of. Sometimes for viewing purposes, it is more convenient to have the vehicles on the planview display appear much larger than they are in the real world, given whatever grid there is here. So you might see things that look like they're side by side, rubbing fenders, marching into the battle, when in fact they are quite apart. The person who is manipulating the display has just exploded it so they're visible to you in the audience. That is a problem and the speaker can comment upon the actual spacing of the vehicles that you're watching. You'll also see on this display an arrow that is manipulated by the fellows at the workstation here. The arrow is the viewpoint that the out-the-window display is actually looking at. You can get some orientation in terms of direction by looking at the center display, finding where the arrow is, and that's the viewpoint that you would see out the center screen over there.

The center screens, the CRTs, are the out-the-window three-dimensional portrayal of the battlefield being modeled. The terrain that we have up right now is Hunter-Liggett in

California, where many tests occur and we have a small sample of material that we'll show in a little while by way of orientation. (Bob, can you go ahead and move us through some of the terrain there.) The flying carpet, that's really what we call this, can free fly, as Bob is doing now. It has dynamics that allow it to go anywhere and stop in midflight. It's in that regard not exactly like any known combat vehicle. It's really an eye on the simulated world. Bob can also ask for a fixed point above ground, and then move across the terrain always at that elevation. When we actually start a simulation and there are vehicles out there, the guys can attach to those vehicles in one of five different modes. I'll talk about those later, and we'll demonstrate them also.

What I'd like you to know (start a short piece of simulation), this is from an actual battle that was fought in simulation, but not in the real world, some time ago. If one records the data traffic on these interactive simulator networks, then it is possible to precisely reconstruct the simulation and return to it as we are doing today. However, not actually playing it back like you would play a video tape back, but playing it back as if you were playing a real world situation back. This allows you to move wherever you want in that battle, observe, get inside combat vehicles, go to places where there were no observers before, and generally, with this phenomenon we call time travel, move about the battlefield, stop, back up time, go to any place that you would like in space and time.

What the fellows did was just start a short section of digital tape that is playing back the network traffic of combat vehicles that were in this particular simulation. From the planview display you can see the placements of the red force down here at the bottom. You can see fixed wing aircraft up here, helicopters here, these will be all tanks or Bradley or BMPs, Soviet equipment. There is a forward blue armor vehicle, and over here other vehicles. Here is the arrow that indicates what we're looking at. You notice we're looking at some vehicles in place on a ridge, and that's what you see in the out-the-window scene. That's the metaphor for the displays that we'll be using today. We'll talk a little bit more in detail as we actually get in to specific parts of the simulation for the first time observers of these kinds of displays. Some orientation is required and thus our comments as we get into different parts of the simulations. If this isn't particularly clear to you, exactly what you're looking at, it will be really important to bring that to our attention so we can take a moment and make sure you really understand the kinds of things you're seeing. That's really essential for you to get the idea of what's going on.

Now, to welcome you on behalf of IDA, I'm pleased to turn the podium over to the President of the Institute for Defense Analyses and the former Chief of Staff of the United States Air Force, General Larry Welch USAF (Ret'd).

--73 EASTING--

WELCOMING COMMENTS

General Larry D. Welch, USAF (Ret'd)
Institute for Defense Analyses

GENERAL LARRY D. WELCH

Well, thank you, Jack. As one of your co-hosts along with DARPA and the Army Center for Military History and ETL, I have the pleasant duty to welcome you to what is certainly going to be a working conference. As discussed in the information that invited you here, we have at least a twofold purpose--in fact--a manyfold purpose. One is to review the prospects and the progress on 73 Easting. And I can tell you that I've already seen enough of that progress to know there's a lot of exciting stuff here. It's exciting stuff for a lot of reasons. The second purpose is to serve the broader purpose of advancing understanding of the potential and what we think will be the future of advanced distributed simulation or distributed interactive simulation, whichever term you prefer.

I can also tell you that, in my short time as President of IDA, I've seen a lot of excitement among analysts about the potential of this approach to improving our understanding of the strategies, concepts, and forces that will win future air, land, and sea battles. I know we all think it's a very good idea to do that. That excitement is also clearly evident in DARPA's senior leadership. This opportunity provided by 73 Easting also comes at a time when sensors, data collection, information processing, communications and display technologies are coming together, or can be brought together, to provide a new capability to add to our understanding of strategies, concepts and forces that will win in the future. That capability simply hasn't been there before and I think that's extremely important.

It's also important that we engage as many bright minds as possible in forecasting and understanding how to use this tremendous potential. I know that as more defense decision makers begin to understand all this, we will see lots of enthusiastic new adherents. We're on the leading edge of that. I'm afraid though that, as is often the case with emerging capabilities, we're in the Wright Brothers' stage of understanding. We need to get supersonic very quickly to use this potential because the need is very clearly there and the capability is emerging rapidly. I'm confident that this conference will add to that kind of understanding and will produce some acceleration. It may even produce some exhilaration, when it comes to how to use this kind of capability to address a lot of vexing problems.

I will be followed by Dr. Vic Reis, the Director of DARPA, with a strategic vision, and then by Major General Funk, the JCS Deputy J3, former commander of the 3rd Armored, who will give the keynote address, so I need not dwell either on the broad vision

nor on the details of 73 Easting. But I will take just a couple of minutes and touch on a few subjects that will be discussed in much greater detail over the course of the next three days.

I will limit myself to subjects where I have personally struggled for years with challenges that it seems to me are particularly susceptible to help from the technologies we will discuss for the next three days. There are lots of reasons to do project 73 Easting But one important reason is simply the opportunity to accurately reconstruct a significant battle and play it over until we understand what happened and what drove the outcome. It's particularly important that it's a highly successful operation that we're able to study in that respect. In a conversation with Dr. Shey from Lincoln Labs, before we walked in here, he mentioned that he had heard a conversation by Ted Williams where he reflected on his success. Ted Williams declared he continued to perform so well over the years because he studied what he was doing when things were going well. So he not only understood what was going wrong, but more importantly understood why things went right.

Certainly, studying battles is not a new and original idea. It is a long accepted way to gain understanding to improve the strategies and concepts in forces to win more often in the future. But it's been my experience that most historic accounts and even personal accounts of the outcome of great battles are based on bare glimpses of the battles seen through breaks in the fog of war. Yet, when you read those accounts or hear those accounts, one gets the impression of an authoritative reconstruction from facts. The real facts are that really the reconstruction is usually woven of glimpses of ground truth with a lot of gaps filled in as best they can. That doesn't mean that the lessons learned from that process are unimportant. It does mean they are not nearly as reliable as we would like them to be.

Let me touch on just one other aspect and then turn the podium over to those who are going to tell us how to move on with this capability. It relates again to the study of battles, since that's what we're doing here. Among the important lessons learned from studying battles from history, is one espoused by Mr. Clausewitz--that chance plays a large role in the outcome of a lot of battles.

But lest we surrender to the vagaries of chance, I would also point out that Mr. Clausewitz stresses that the quality of the soldiers, their training and leadership determines their ability to take advantage of good chance and their ability to minimize the impact of bad chance. You will see clearly as the battle of 73 Easting unfolds that we did have valid strategies and concepts. We did have forces that were prepared, trained, equipped and who understood the concepts, had the mental mindset to take advantage of

good chance. Fortunately, we were operating against an opponent who didn't have the ability to minimize the impacts of bad chance. Chance played a role in 73 Easting. But you will also see compelling evidence that will give you the clear conviction it was neither chance nor the weakness of the enemy that drove the outcome of the battle of 73 Easting, that provided such a stunning, overwhelming victory over what should have been a very formidable Iraqi force. My point is the importance of understanding what kinds of strategies, concepts and forces build capability to deal with uncertainties on the battlefield and uncertainties in the world. In the emerging disorderly "New World Order," understanding the concepts, strategies and forces that do that will be important for defense decision makers. The kinds of capabilities and technologies we'll discuss over the next three days give the opportunity to understand what went right, which is important. It also has the potential to give us the capability to re-fight important battles like this one and to vary the commander decisions, equipment capabilities and the weather, etc., so we get a better understanding of how to build in resilience and adaptability and other qualities that provide forces that can deal with the real world as it unfolds.

There are a lot of other exciting applications. I have the pleasure of serving on a panel tomorrow afternoon that will talk about a lot of those possible applications. It would be highly presumptive of me to try to open this conference with a comprehensive listing of those potentials, but, I am confident that out of this will come a more comprehensive listing, and more important, a much more solid understanding of where we can go from here.

And now to get started with hearing from people who are going to help us understand that, let me surrender the podium.

--73 EASTING--

STRATEGIC OVERVIEW

Dr. Vic Reis
Director, Defense Advanced Research Projects Agency
(now Director, Defense Research and Engineering)

DR. VIC REIS

Thanks, Jack. General Welch, General Funk, etc. This is really a pleasure for me. It's a very difficult job to capture all the things that 73 Easting has put together. I did try to put a few charts together to explain where I'm coming from on this. Let me look at the first chart.

What I'd like to give is a very short talk on what I call technology, history and simulation because what we're dealing with here is really the conjunction of all three of these. I'd like to be able to use 73 Easting as a paradigm, or as a model for what all this means; how this all comes together. If you don't mind my getting into jargon a little bit, what we're talking about here is really a paradigm shift. If you look at the Thomas Keene approach that says we visualize the world through models and every now and then something comes along which allows us to change the way we see things. I think the work on synthetic environments, SIMNET and all the things that are coming together, if you will, at the 73 Easting will really be a watershed both in terms of understanding history and in the way history will be looked at in the future. That's a rather tall order, but I think we're up to it.

CAPTURING THE TECHNOLOGY REVOLUTION FOR DEFENSE

THE ROLE OF SIMULATION

This chart describes a little bit about how the technology is really accelerating and expanding in the areas of transistors which we make into chips, which we then make into computers. Now and then we tied those computers together and that's the base technology which is allowing all this to happen. So I'd like to get some data on this to describe what this is all about. The slide shows the number of transistors per year that are being produced, compared with the rate of which the total world population is going. Most things, if you think about historic things, go with the world population. Occasionally

something occurs that's different, such as nuclear weapons, or from conventional weapons that are real accelerations. This is the first one that if you project that a little bit further in time what you come up with in a few years, for every man, woman and child in the total world we will be producing every year twenty million transistors. Think about that. That's everyone. That's a lot of transistors. A few years ago, when General Gorman was a boy, there wasn't even such a thing as a tube. That's where we're moving in transistors. Now what do we do with all these transistors? After all, all they do is blink on and off by and large. Well, one thing to do is we make chips out of them. The next chart I hope will show how we build them into circuits.

TRANSISTORS PRODUCED PER YEAR

TRANSISTORS PRODUCED
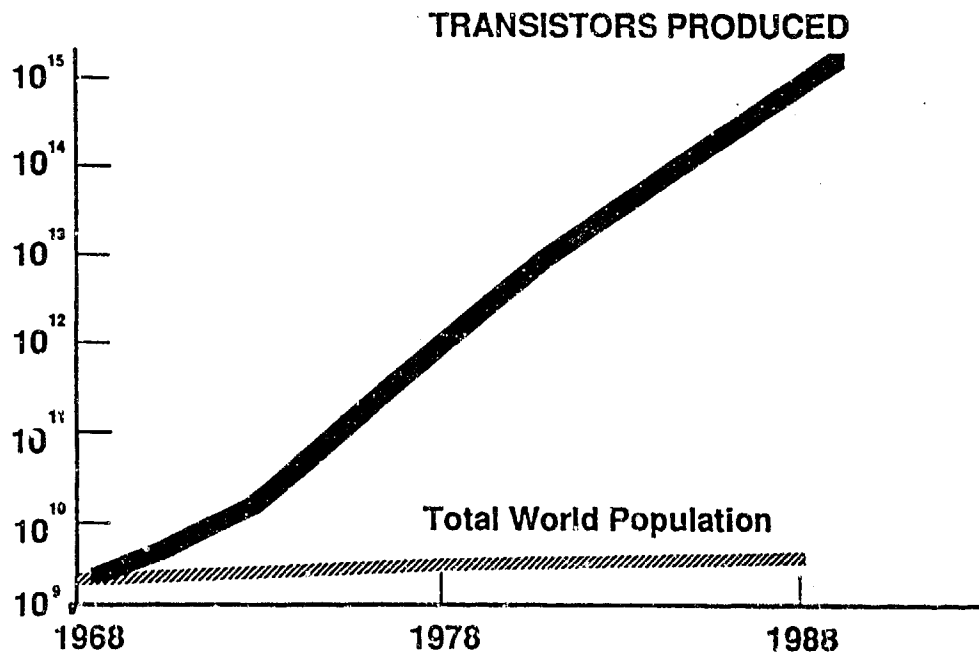
This is a chart that shows some data, maybe in 1968 or so, why in the integrated circuit which was just coming on board and a hundred or so transistors were considered a lot. We're now talking about them in the millions and people are projecting by the end of the decade we'll have circuits that will have a billion transistors. That's a lot of information crammed into that. A lot of decision making capability put on to that one little chip. What do we do with the chips? Well, one thing we do is make computers.

PRODUCT COMPLEXITY
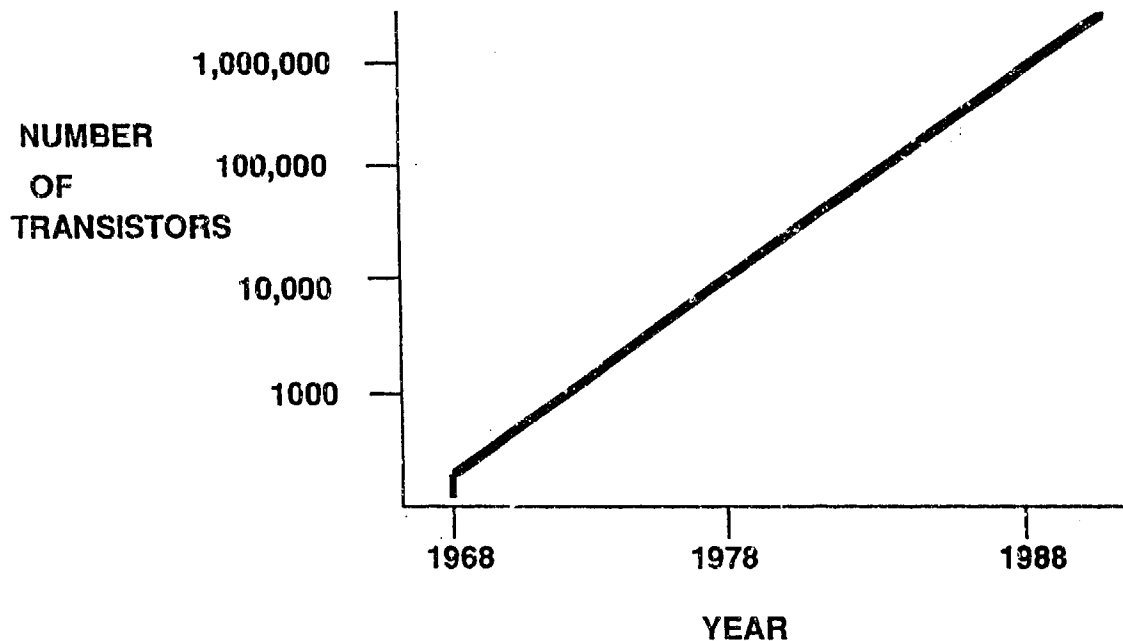
The next slide shows the rate at which instructions per second or the speed of computers have been going over time. That was moving along quite well at the beginning of the decade, people would talk about MIPS as being something important. We're now getting into the millions of operations per second. We're now of course moving into the area where we're getting up to a 10th of a 12th or Terraops. What you're seeing is that break in the curve of course was the interaction of large parallel systems which is the foundation of the DARPA, the Departments and the national high performance computing and communications program. We really are moving up on that curve. What's interesting enough about those systems is that they're scalable, so you don't necessarily need a very large machine to give you Terraops. That same technology will give you Gigaops and something about the size of this podium and megaops about the size of this microphone. So we can compute everything. Now what are we doing with all those computers? Well one thing we're doing is we're tying them all together so you can sit at your desk and be in contact with all this computing power.

Computing System Performance Trends
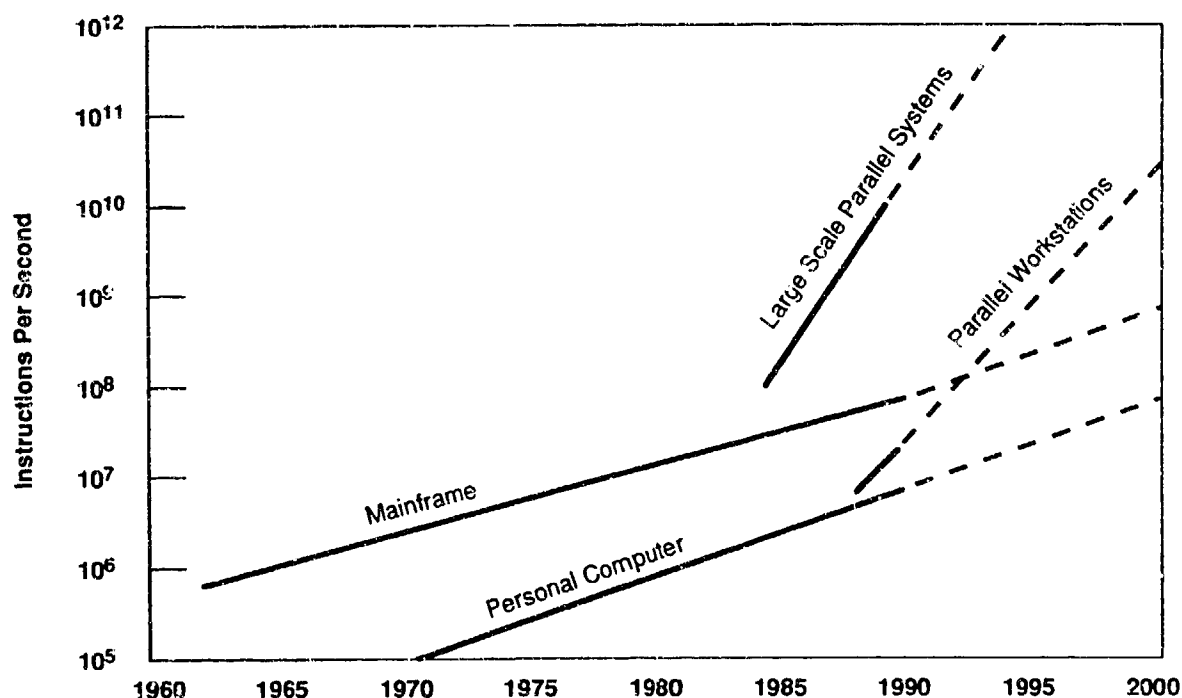
The next chart (I didn't quite get that into a figure, but you can put that in your head), the ARPAnet, is just one of the networks. The growth of the ARPAnet, as it's grown there, were four computers tied together in 1968 and we're projecting for the Internet something like ten million computers tied into those. Remember, those are not just small computers, those are the same terraop computers and megaop computers and all those things that we talked about. This is the future. The information technology and it's the future that I am sort of sitting on at DARPA, because we are funding much of this work. The question that I started to ask, what in the world are we doing with all this stuff? I think it was Emerson or Thoreau, I can never remember which one was which, when he said that "Gee, we now can string a telephone line from Maine to Florida" and he said "What are they going to say to each other?" So what are we going to do with all these computers? This network of all these operations, chips and transistors blinking on and off. Well, the first thing that people think of is we solve hard problems. It's traditionally those problems that are computationally intensive that we've never been able to get to before and really work at. Things like global weather systems, computational fluid dynamics to reduce the load on wind tunnels, all sorts of weapon systems design, clearly is the role for all these solving the "naviar-stokes" equations with turbulence and so forth and so on. Those types

of problems are now opening up and that's certainly very, very interesting as well. But there's something more profound and that's the second class of things that we can do and that help us make decisions. That's really what we do in life, we solve problems. But then we get some such of things that we have to make decisions. Whether on the battlefield, the plan for the battlefield, in business or whatever, we fundamentally make decisions. Here's where that network can really play, because what it can provide for us is the ability to look at alternate choices we can make. That really is something. Believe it, and really believe it. That is something really new and very profound and that's where the 73 Easting is really a start on that role.

Achieving Teraops Computing in the 1990s

Sustained Computational Power in op/s

- 1 Tera
- 100 Giga
- 10 Giga
- 1 Giga
- 100 Mega

DARPA Teraops by mid 1990s

Scalable Design

Intel Touchstone
TMC 0.1 Mega CM
CMU/Intel IWarp N

ULSI

LSI

Intel IPSC/860
TMC 64K CM-2

MSI

Teraops beyond 2000 **?**

TMC 64K CM-1

VLSI

CMU/GE 10 Warp
TMC 16K CM-1

Conventional Design

1980   1990   2000

Performance = Scale * Design * Package * Integration * Clock
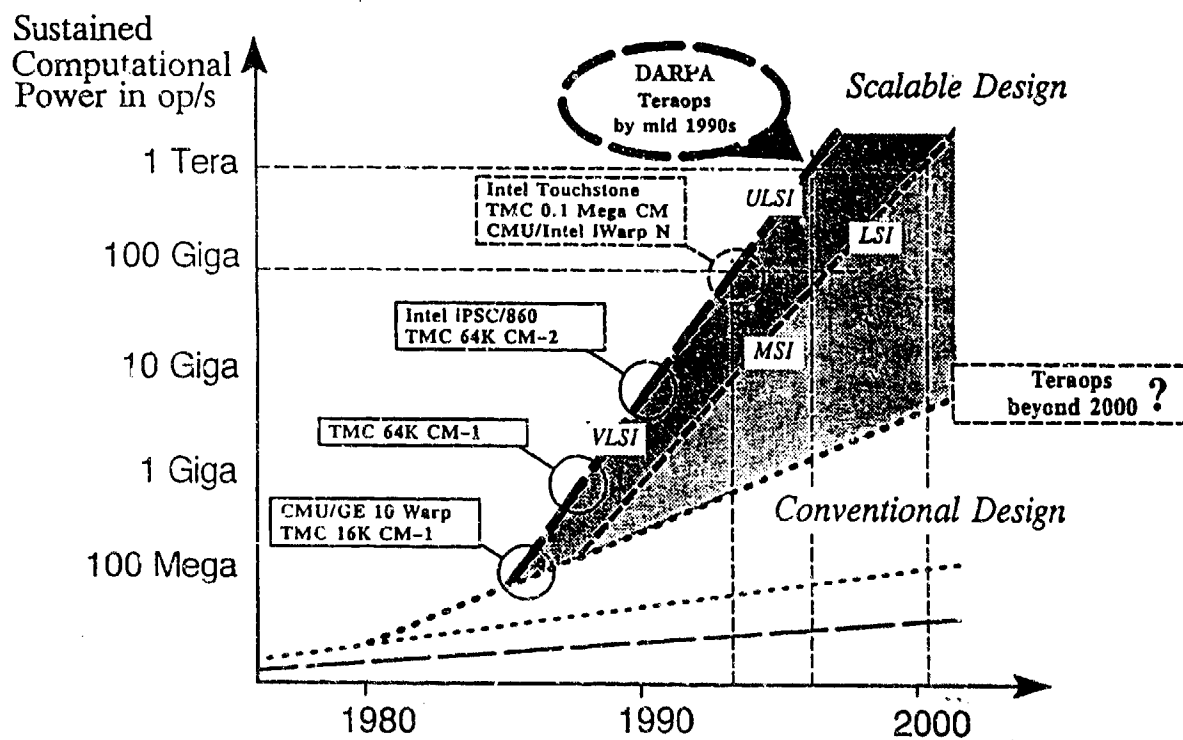
The next chart gets into the fundamentally new ways of thinking about these things and that's what makes them so exciting. First of all, its multi-dimensional in both space and time. Several people have mentioned to me that one of the things they tried to study, one of the things that made great commanders is their ability to look at a two-dimensional map with scribblings on it and put that in their head, if you will, and see in three dimensions and in fact in four dimensions be able to move that three-dimensional thing in time both for his own forces and for the opposing forces. To be able to create that battlefield. Now, with the type of technology we're talking about, we can make great

commanders perhaps, or at least enhance that ability. So it's this idea of moving in multi-dimensions which I think is new and very exciting. Many parties can be involved in this, it isn't just one player and his idea. Any one of you who have been involved in trying to think of what to do, the first thing you do, at least what I do, is I go to a blackboard and invite three or four friends in and you brainstorm. You try to do the best you can. It's an incredibly creative process anytime you have a problem you bring people in and try to work that. Well, this is a way of really doing that in a much broader scale. In addition it allows you to red team. To work on antagonistic areas as well as cooperative. It's a technology that allows if not a new way of thinking, then a new approach to very effective ways of thinking. It's multimedia. You can see where sound and text and all sorts of things get involved in this, and it's archivable. In other words, it isn't just what you've done on that blackboard, it's now captured. We can now study and think about it, and understand it. General Welch's comments and Ted Williams' comments are very appropriate here. It allows you to really go back and think through the effort and then project that forward as well. Of course, the bottom line that gets back to the decisions, it really allows you to do the whole "what if" thing. I don't know quite how to explain that other than it's "what-iffing". It allows you to look at alternatives. The thing about 73 Easting is that it allows you some confidence in being able to look at those what-ifs. So it starts this whole boot-strapping approach of what we're going to be doing with all those systems.

The Electronic Sand Table For Operations
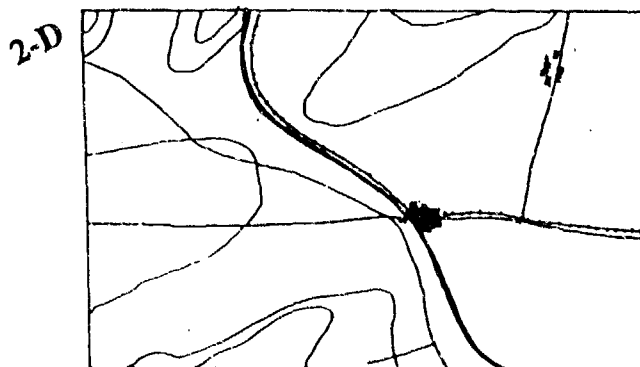
Moving From
2-D Into 3-D

Synthetic Battlefield
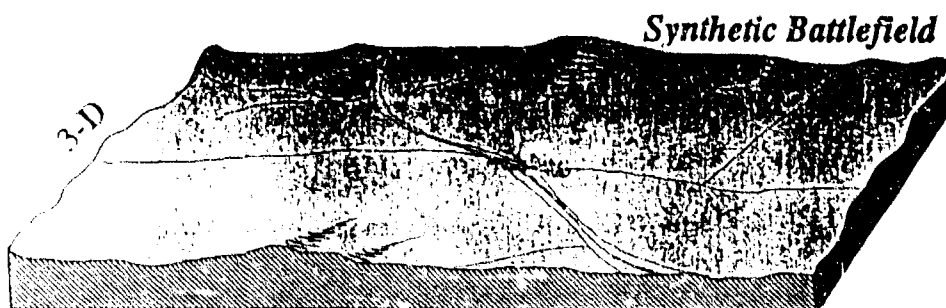
In the Department, we're all concerned about what is this new world order going to be. The events last week are fairly dramatic. I would have to say, in terms of a new world order, there's no question that there's going to be a new world order. And the capture...I would slowly try to project what that might be other than it will be very uncertain and we've got to think of new ways of handling that problem both from a military perspective and of course from a diplomatic perspective and other things as well. So we really are having three things that are fundamentally in conjunction. First of all we've got to understand the history of this thing, and 73 Easting. The whole Desert Storm experience was a genuinely historic event. Those of you who are working in the Defense Department and in the military services or contractors, the difference between being in the Defense Department now and being in the Defense Department a year ago is like going to a party instead of a funeral. I mean it really is a very different place. The whole historical map, if you will, has changed. Secondly, I think, is the interaction of this with technology and what I tried to describe very briefly is this technology in the information sciences, the electronics and all the things that go with that are just exploding now. If you take this historic event, and the ability to have this technology, it really is the creation of new ideas, new ways of thinking, the new ways of approaching problems that I think, again, is historical in terms of our ability to do this. I think this conference and 73 Easting and all the work that's gone into that is a real start. It's a real watershed in making that. It can really be a paradigm shift.

Now--what it is that you can help. I mean, why did we have this conference? First of all I think it's to share the vision. Because I think there is a vision. There is a genuine watershed. A paradigm shift. You can use any word you want. Potential historic change in the way we think about combat, training for combat, and buying new weapons for this. In fact, the way we deal with the entire national competitive situation. I think this is potentially a chance to do that. But you have to do something. You have to get started and 73 Easting is a real event. It's a real example of a time where we can do that. So the reason you're here is not just to enjoy the weather (it's pouring out), but it really is to think hard about--do we have the right vision? Can I share this vision? And in particular, how can I improve the product? This is a start. We think it's a very good start. We think it's an excellent one. It's a conjunction of a number of things. If you're an astrology professor, you'd appreciate that. The key to what we're doing is we've got to make this thing better. That's why we invited a lot of people fairly early in the game, while we still have a product that is not complete. It's not in the can. To try to say how can we make this particular one better. Then in particular stimulate your minds to thinking about how

can we use this technique to change the world. That's really what we're trying to do here. Thank you very much. Now, if there are questions, I'll be glad to answer some.

Q: Where is the pull of technology eventually going to lead us?

A: (REIS) It's hard to say. It almost seems unbounded. Sooner or later all those things, I suppose, connect with the number of neurons in the people's heads, times the number of people, and you know that's a number that's still pretty large compared to most of that. These things don't seem to be turning over. Let me change your question a little bit to something I know the answer of, I think. What's happened now is, there's no way that curve is turning over so there's no plateau there that I can see or find anybody else that can see. We're working on whole series of getting down to structures that are very, very small, in terms of this transistors techniques for building chips forever, and people are talking about pettaops, in terms of computation. So there doesn't seem to be, over the next 10 or 15 or some years like that, a real technological barrier. The barrier is how do you ride that curve, so that the technology doesn't get out in front of our ability to use that technology. Let me give an example from a different air, here in the satellite business. The satellite business economy of scale always works, you know it's always better to build a bigger satellite. When you look at the number of circuits you want to put on a satellite or how long you want to keep it up in space, it always tended to be bigger. Now with the technology moving along very fast, that may not be the best thing. The economy as a scale no longer works because you now have to figure out how to ride that technology acceleration. That's why, by the way, this stuff is so important. That's why the idea of saying I can now solve which war is essentially a social problem, and how do I win better? Training is a social problem. How do I use that technology for these types of systems is really where the barrier is to making these things happen. It isn't so much a technology pull, I mean the technology is sort of racing along, I won't say out of control, it's being controlled fundamentally by other forces. The issue is, how do I get that technology to do something that will make an impact. I believe this is why 73 Easting is so important. Beyond its own ability to capture this battle because what it does is take this simulation business, takes this multiple thinking and put it back into something real. A real event that really happened. It's validation and verificational. All those things one talks about and then the thinking that goes on to that product and how to improve it will clearly give us a direction in terms of what one does next.

Q: You quoted Clausewitz on chance...

A: (REIS) Welch did.

I-22

Q: You also made a lot of points on talking about how difficult it was to clearly analyze warfare, because there are so many variables, so many activities. It strikes me that with all of this great computing power, you don't know how to handle the data, and it might be interesting when Mike talks to let us get a flavor of the methods used to gather the data which you are going to be using to model that data and I suspect that we didn't get everything we knew about, even with that. That seems to me to be a problem, a troubling fact...

A: (REIS) Yes, certainly the collection of the right kind of data is really going to be a limiting factor. I think the only way you do that is to do the exercise though. Then you learn what's the data that you missed and then you're prepared to collect that data next time. I think though some of the words that Jack uses or some of the people from the simulation, they're talking about seamless simulations. It isn't just simulation for training or simulation for concepts. It's seamless and it becomes part of the battlefield. So you're collecting the right type of data because the simulation goes along with you. It is the electronic sand table, if you will.

General Funk and I gave talks down at the Army conference on what should the Army be doing in the future and he showed the sand table in Desert Storm. It was the sand and they were really out there. They had the sand and--lots of raw material--these transistors are sand too, it's just a question of how you organize them a little bit differently. That's what's so interesting about all this--it's all sand. Right? So was New York City, when you think about it. So it's a question of how you can build a seamless environment. I hate to use the word simulation because it's really much more than a seamless environment that goes all the way from training to acquisition to bringing that equipment along with you. So you know what data to collect--see we don't know what data to collect. The people were not sent out there to collect data. They were sent out there to do a mission. We kind of collected the data after the fact. Maybe if they're collecting the data in real time and use that. Now indeed one can begin to shorten that cycle. But you've got to start.

There's no question about it, I think your observation is absolutely correct. There's going to be all sorts of barriers that we come through, but the idea of this one is you're working on a real, the people were really there, they really participated in making this sort of thing. It's like a scenario, but you don't have actors, right? They're the guys who really did it. They know what's happening.

--73 EASTING--

KEYNOTE ADDRESS

Major General Paul Funk, USA
The Joint Staff, OSD

MAJOR GENERAL PAUL FUNK

I want to make some opening remarks, go to a tape to depict some of the conditions of the battlefield there, show you a few slides and talk about fighting only so far as I know it in the great 7th Corps; commanded by a marvelous leader, now General Fred Franks, and mostly focus on the 3rd Armored Division.

I think just about everybody has been thanked this morning for all this. I want to particularly mention Jack Thorpe and Neale Cosby. Neale has brought me into the project, kept me well informed and pointed me in the right direction when I didn't even know where the Radisson Hotel was, and I appreciate that. I also appreciate General Welch and Dr. Reis inviting me to participate and of course Mike Krause and everyone from the Center of Military History.

I've watched the advanced simulation program from the start. I didn't have any of the ideas, I want you to understand that. But I was at Fort Knox when the program began and when General Brown was the risk taker and said we should bring it to Fort Knox and we'll figure out a way to pay for power and things like that--which was just one of the considerations in those days. The budgets weren't too darn shiny about that time in TRADOC either. But furthermore, to watch this to see the difference then of our most successful, in my view, simulation out at the National Training Center, then to go to Europe to use the SIMNET which was the technology demonstrator, and to come back here and see what's being done advancing all of that at a really tremendous pace, by Jack Thorpe. Jack has been a driver behind this, a wonderful human being as well as being very, very bright. We owe him a lot, and I mean that. I'd also like to acknowledge the guys who led us across the border into Iraq, the 2ACR. Unfortunately, Don Holder, now Brigadier General Don Holder, can't be here, but I want to acknowledge him and all the great performances by those guys, as you will see later on in the fight. I know Doug Lute is here; don't know if he's here now, he'll be here this afternoon. He also has another job, so he can't be here full time today. Somebody said Mac Hazard is here, is Mac here? Some of you may know Haphazard--one of my genuine heroes, and a guy that knows more about combat than perhaps any of us ever will. He was a motorcycle scout in the big red one, World War II; I think four silver stars, one or two distinguished service crosses, and a great soldier. That's his son who fought and led K-troop of the second regiment there. I think all the forces that fought over there deserve a lot of praise and I'm going to talk about that as I go along.

I think we should understand that we sent the best prepared army ever to that war. I didn't say that we were the "best army" the U.S. ever fielded. I don't want to offend anybody in that regard, but I will tell you we went there as the best prepared army this nation has ever put in the field and I hope we don't forget that. We really shouldn't. I want to talk a little bit more about that later on and how it relates to this project because the soldiers that went over there and performed so brilliantly were raised on simulation. They're probably the first generation, as far as the Army's concerned, of simulation trained combat soldiers. I think that's an important point of departure here and certainly it's also true in the Navy and the Air Force on the side of simulation for all kinds of aircraft--but the folks from the Navy, Air Force and the Marines know a lot more about that than I do. The seeds of that victory, in my opinion, were sown about 15-20 years ago. They started with the big five combat systems, but perhaps an even more important event for me was when I sat in a conference as a Major of little consequence from Fort Knox, and watched General Dupuy as he created what became known as the TRADOC School Model--which some have cursed, but anybody that understands, would know that it was a seminal event because of the focus on education and training. I use those words, education and training interchangeably. I'm not willing to approach the argument of how many angels can dance on the head of a pin. The fact is, what he set in motion was a training system crafted by General Gorman. He was an absolute visionary of his time and remains that in my opinion. He is no longer in the army, but has a great, great mind and has done marvelous things for us. He prepared a little T.V. tape on the electronics of the future in terms of the military, specifically the Army, about 15 years ago. It was absolutely right on target--most of us couldn't even see, far less spell transistor at that time. I just want to give credit where it's due.

I also want to tell you that General Dupuy was and still is a genius. He can take very, very difficult things and construct out of those, ways for the rest of us to learn about them, understand them and more importantly, apply them to the battlefield. That had not been done before. If you want to read something very instructive, his oral history has been done at the War College. It is, in my opinion, a brilliant piece and tells you a lot about the shaping of an army. I wrote to General Dupuy before the war started and said to him "Sir, I don't know exactly how this is going to turn out. I know I have great confidence in our people and equipment, but I will tell you the reason we've come this far and are this well prepared rests primarily with you and people like General Starry, General Otis, General Vuono, General Cavazos and others." All of them are out of the army now, so I think I

can say that without being too maudlin about it. The fact is, all of those people raised under General Dupuy's tutelage had a dramatic impact on this victory, and training system he put in effect. In my opinion, no General or Generals, no book, no doctrine, no equipment had the impact on that battlefield that the high quality, trained soldiers, of all ranks--at least I can speak to the ranks up through Lt. Colonel and Colonel--all of them prepared in this system. That is what made the difference and why this fight went so quickly. General Franks has a great expression, "It was fast, it was quick, but it wasn't easy," and it wasn't. All of you out there that shared in growing this system and those of you who are going to share in the future, can take a lot of credit for it. It's very important to understand that. (I was just talking to some of the fellows in the hall.) I can't imagine that anybody doesn't understand that training was the real difference between our army and Saddam Hussein's. It really and truly was.

The most powerful driver of training in my time in the army, 28 years now, has been the National Training Center and what it has spawned. The National Training area is a high fidelity simulation, driven by realism of terrain and weather, and I'm going to talk a little about MET-T as we go through this exercise. Those risk takers who did so much, much like Jack Thorpe does now for Dr. Reis, have done us a world of good here and this system that we're talking about today is just the beginning. I think that as we look 15 years in the future, we don't have as clear a vision as we had back with the big 5 and a training system that was based on experience, i.e., experiential learning, and honest straightforward evaluation. Make no mistake about it, the real difference all of our combat training centers, including the battle command training program--to which I can see great applications of the technologies here now--evaluation whose purpose is the enhancement of performance, is the key to how we got that much better in that period of time. Most of us were raised in a system where the public and private schools, the colleges and universities, in our country, believe the real purpose of evaluation is to give some poor dummy like Funk a grade. Well the fact is, that's not the real purpose in a learning environment. The real purpose is to enhance performance. We've become pretty self-critical. When you have young privates telling their platoon leaders what it is they did wrong--in their opinion--on the last fight, then you've got something. You've got privates that understand they're every bit a part of the solution; they are not the problem. You've got Sergeants that really understand how to evaluate training and then make corrections, not by kicking somebody's butt, or drilling them harder on the parade ground, but drilling them harder at Grafenwöhr, Hoenfeld's, the

National Training Center, the ranges at Ft. Hood, etc.--that's how you learn in the Army. I think that's what we're about here today. It has great impact for the Army.

If I could put on a joint hat briefly and it's my first time on the Joint Staff, first time in Washington, first time at the Pentagon, so I think you can still trust me a little bit. I told some of the guys maybe four or five more months and I think it's in the water, maybe that's, I don't know, I know that's true over at Tappa, the Army personnel command. The fact is that all of this is very important to our future. Some Brits, one time in the past, seem to put it right, "So now that we have no money we shall have to think." The fact is, at least in terms of the Army, the budget's gone way down and we do have to think. We have to somehow leverage technologies to help us get even better because there are folks out there in the world who look very closely at this victory and they can draw some conclusions too. To get it down to the bottom line in that regard, the old Bum Phillips line somebody was talking to him about Don Shula and he said "Shula's a great coach; Shula can take his'n and beat your'n, or take your'n and beat his'n." Our soldiers could have taken Soviet equipment and won that war too. Not as dramatically, in my opinion, not as quickly, but they could have done it. So the difference there is training, the delta that General Gorman and other very bright people have talked about over the years. It's still very important to us.

What you're going to see here today are the facts, as best as we can collect them, as somebody pointed out earlier. The difference now to add sound, sight and (sight in terms of the video) even things like dust, rain and all those kinds of things that happen to us on that battlefield--that's going to be a great leap forward in experiential learning. I truly believe that. I also think this whole business of a stealth vehicle or a magic carpet that can go about the battlefield without impacting on anybody out there, is extremely important for commanders to be able to look at and determine what really did happen. Terribly important. And for us to help learn the lessons again, of focused evaluation. I think it's also a doctrinal tool. In the sense that General Dupuy meant when he said that doctrine is what 51 percent of the guys out in the battlefield are using. But it's a way to develop doctrine and to verify it. I think it's useful for unit commanders, for those who have worked in the schoolhouses as I have done on a couple of occasions, for people in research and development, and yes, for the testing community. All of this kind of goes back to the business about money, and it always seems to boil down to that around here, in fact it will save some money.

What I want to do now is quickly go through a briefing that usually takes about an hour and a half. I want to talk to you a little bit about the fight in the 3rd Armored Division. I'm going to go as quickly as I can, then I'm going to come back for some quick summary remarks and then we'll get on to a couple of questions if anybody has them. I want to roll a short tape now. This is to show you a few battlefield conditions and let you listen to some of the voices. You're going to hear commanders and after-action reviews a few days after the fight. You're going to hear a young Sergeant who took some real gas, very unemotionally talk about how the fighting went and how he and his crew knocked out several systems. You're also going to hear and see a young hero introduced by the Secretary of Defense. That's probably the best and clearest piece of tape we have, it's only about 5 minutes and 38 seconds long, but I'd like you to watch the conditions there, listen to the voices, look at the faces and get a sense for this human element that combat is really more about than anything else. That goes to the question the gentleman asked earlier and it's so important how we focus our efforts in this area. So please if we could roll the tape, Bob.

(Tape is on at this point) This is the berm going into Iraq. That's the great 2/67 Armor, I think. What a great tank. Followed by a great fighting vehicle. Very close together you notice, because we were hurrying at this time to get north to try to cut off the Republican Guard. About 25 meter intervals is what we were trying for even in that dust. Now look at the weather, look what's happening to it. It's the first day, the first afternoon. (tape dialogue) *"It's a T-72 up to about its turret. And we'll be engaged at 1542 meters with the hell fire missile. And I'll lock on before launch. That's the reason you have the large box that's gone solid. And now you'll see the missile launch. Look's like he's going in there. Yeah. All right. How do ya like that."* Billy Stevens, great commander. *"Look at that secondary."* That's what happened to most of the T-72's that were hit.

"We came over this little rise and my gunner was scanning through the sites he noticed the dismounted infantry out there and as I was calling it up we started engaging. Then you noticed a BMP out there so we started engaging that and after we destroyed it we continued to scan and found two more BMPs and a tank out there we destroyed them, we were engaged by a T72 who shot two sabo rounds at the tracks during which time I was trying to bandage up my driver and caught the flash burns on the side of my face we got to the troop trains and to the medics and they took care of us sir."

(Funk) There's a track, he was in the Bradley, notice it did not burn.

"It was real strange. We saw coming from the far east towards us a truck full of troops. They saw us and slammed on the brakes all jumped out and looked at us. They didn't raise their hands, they just got out and looked at us. We went up and we got around them and the Lieutenant that was in charge said we couldn't believe it, we were told all the Americans were dead. They just looked at us in awe."

"They actually told me you could see the RPG bouncing off the tanks. I said well, I feel pretty good about that." (Master of understatement, Chuck Haldman, tank commander.) "We went back there and looked, most of the stuff on the tanks, at least in the Delta and Charlie company, have these little scratch marks on them. I don't think they took any significant, no real damage other than that RPG that hit the 50 and went into the TC turret."

"We picked up hot spots in the thermals 6 clicks out, we had 5800 meters in the range finder. We blew up some BMPs..." (another soldier) "The first sergeant got shot at..." "After we started going, after the contact we started going out in the wedge, we started taking fire from the right flank. And in fact..."

(another soldier) "...4-32 had gotten in a fight with and was still trying to get more." (another soldier) "Probably, probably."

"What happened was, the alpha company first sergeant who was about three clicks behind his company says hey I'm taking fire from a BMP. So he came to the action reared with a platoon and his xo and they came up on a BMP, a BRDM and some trucks. I want to tell you, that sabot round put a BMP turret, two tanks fired at the same time...bad gunnery, well, great gunnery, bad timing. The fireball went fifty feet in the air and the turret went on top."

"You can allocate fires for the direct fire fight, but you can't control them." (We couldn't have done this 10 years ago in the Army what he's going to describe.) "You've got to trust your company commanders, that you've got them looking in their sectors, and that they know where to shoot, and you're telling them where the other guys are, because they have to control that fight. And you have to move forces, but they have to control the fight." (Funk) Best way to train that may be simulation, by the way, fire distribution.

(USO 50th Anniversary show) (CHENEY) "There's a saying in the military, Army life is measured in hours, weeks and months of boredom interrupted by moments of sheer terror. A lot of our young people were heroic during these moments.

Private Frank Braddish is one who will never forget his moment of truth. When U.S. forces were charging across Iraq on the heels of the Republican Guard, Private Frank Braddish was in a Bradley fighting vehicle with four buddies. Suddenly they were hit by a shell from an Iraqi tank. The round shattered the inside of the Bradley, severly injured the five Americans. One by one Private Braddish dragged his four buddies from the burning tank and laid them on the sand out of harm's way."

(Braddish in hospital bed) *"I thought I was already dying because I got hit in the main arteries in the legs and when those go out you don't have very much of a chance, and especially where we were. I thought, if I'm going out I might as well help the others." "Frank found a flare to call the medics but he couldn't open it with his injured hands, so he bit off the top. When the other members of the Army unit came on the scene, Private Braddish was back inside trying to drag out the heavy belts and machine gun bullets lest they explode and shoot up his mates." If I'm a modern day hero, I guess I am what I am, as Popeye would say, but I don't know what to think about it. I don't feel what I did was a heroic deed, just something I had to do. It was the call of duty, the call of duty doesn't say once you're wounded your call of duty ends. It says the call of duty is until you're dead. So the American people had a lot to do with the victory. "We asked Frank to say something to us on this 50th anniversary of the USO." "Happy 50th anniversary USO."* (He is saluting from his hospital bed) (Back to USO show audience) *"Here is one of the young American heroes that we are all so proud of, Private Frank Braddish."*

Could I have the first slide? Let me tell you, nobody topped that young man, he was raised that way. Nobody taught him to say the call of duty comes and ends when you die. Nobody hammered that into him. That's the kind of young people we have. That's what this conference is all about, in my opinion, and we can get even better.

3D ARMORED DIVISION
OPERATION DESERT STORM

Iraq

Kuwait

Saudi Arabia

3

SPEARHEAD

3

OPERATION DESERT STORM

SPEARHEAD
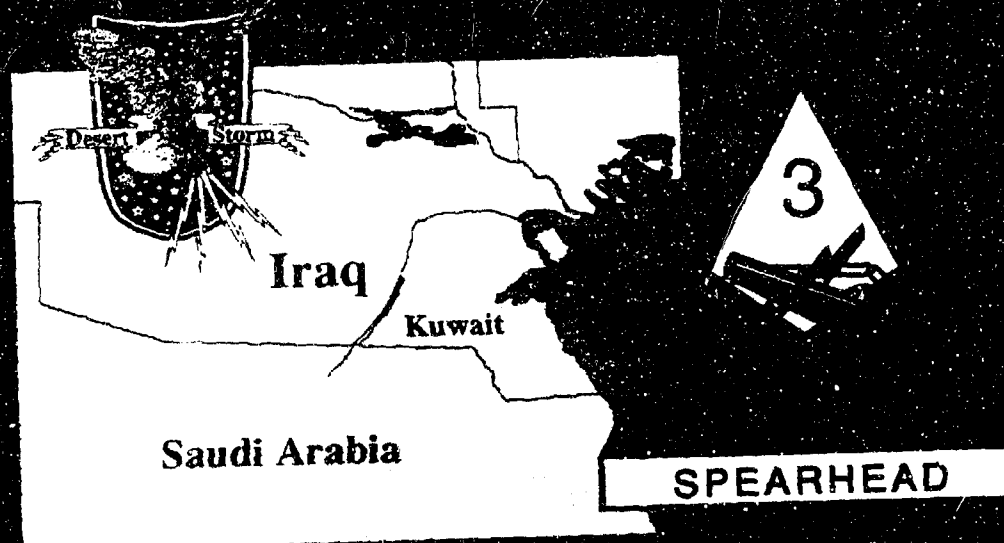
PHASES OF OPERATION
DESERT SPEAR

1 - MOVEMENT FROM PORTS TO TAA HENRY

2 - MOVEMENT TO FAA BUTTS

3 - PASSAGE OF OBSTACLE SYSTEM

4 - MOVEMENT TO OBJECTIVE COLLINS

5 - DESTRUCTION OF THE REPUBLICAN
    GUARDS FORCES COMMAND

6 - DEFENSE OF NORTHERN KUWAIT

I-34

This is what we're going to talk about, spearhead division. Here's our mission. This is a MET-T briefing; mission, enemy terrain and weather, troops available and time. I won't say much about time or the troops available except to compliment them. I would like to focus on the word destroy. That was the mission; the first time I heard it being given was when General Schwarzkopf gave it to all his division commanders and above in November when we flew down there right after we were alerted. He said, "Destroy--don't chase them out of Kuwait, don't defeat them, but destroy the Republican Guards."

(next slide) I want to remind you of the enemy, 43 divisions, whatever their strength was. Nobody has figured all that out yet, I don't know if they will. I want you to look at how they are positioned. These divisions right along the front line here, which we faced a few here in the 7th Corps--actually 4 of them-they didn't fight very well. You already have seen that. This is the Wadi Al Batin. It did not turn out to be a hindrance to vehicular traffic, but it was one we were concerned about. It kind of naturally divides Iraq and Kuwait.

CONFIRMED ENEMY SITUATION 1:50,000
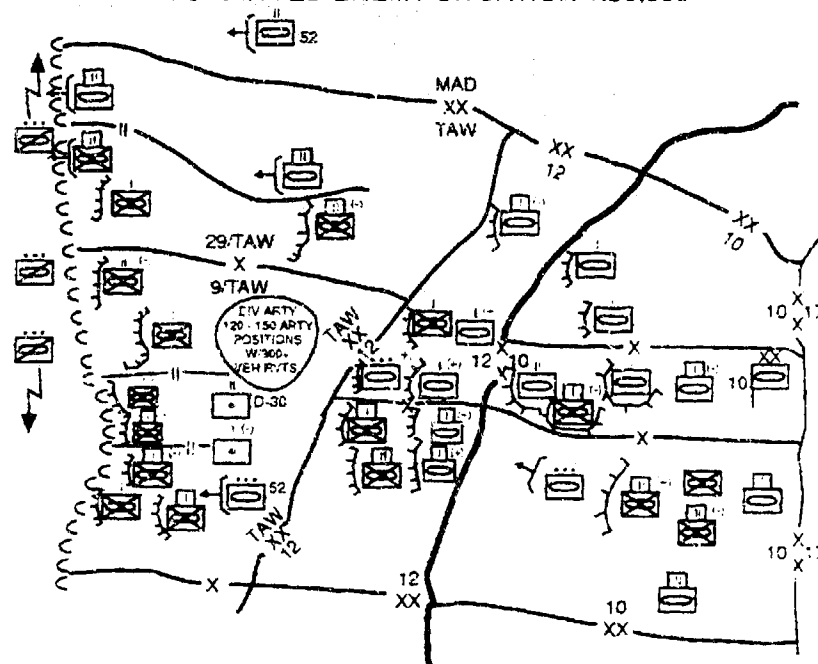
(next slide) I just put this slide up to remind you where the troops were. You remember the Saudi Arabian National Guard was over here with Qatar and some others. The great U.S. Marines were here, then we had the joint forces command north. Syrians, Egyptians and Saudis led by a Saudi General. You had the first cavalry division minus what started out as a central command and reserve and was handed off to General Franks on the second day of the war, I believe. Kind of out of sequence here, there was second ACR, 3rd Armored Division, and 1st Armored Division on our left, and then the big red one which was really over here on the right flank. The great 18th corp out here with the 6 French forces. I put Collins up here just to tell you that's an objective upon which to orient, but the real objective here was the Republican Guards. If you're a principles of war kind of person then you shouldn't forget that, because we didn't.

G - DAY
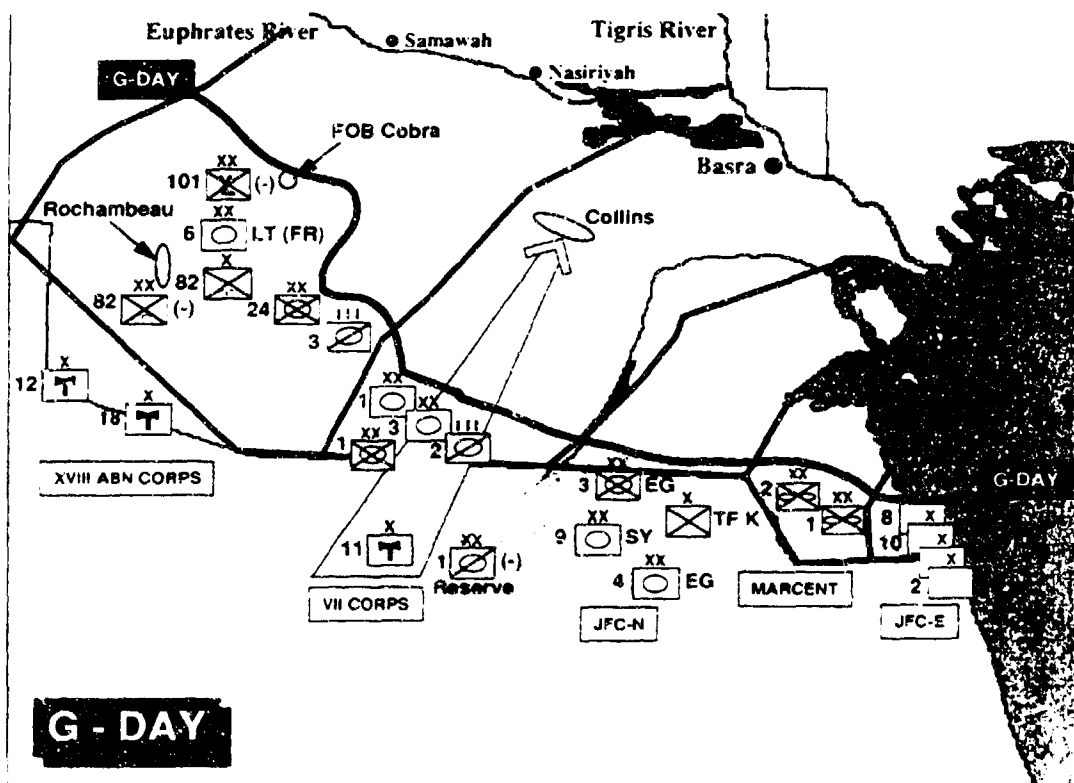
OPERATION DESERT STORM

COMMANDER'S INTENT

PHASE 1 - MOVEMENT FROM PORTS TO TAA

PHASE 2 - MOVEMENT TO FAA

- TRAIN AND REHEARSE AS YOU PLAN TO FIGHT
- I AM CONCERNED ABOUT DIRECT AND INDIRECT FIRE CONTROL
- FOCUS ON MOVEMENT OF BRIGADE-SIZE ELEMENTS
- MOBILITY IS THE KEY TO 3AD OPERATIONS
- AGGRESSIVE IN PATROLLING AND COUNTER-RECONNAISSANCE

1-37

SPEARHEAD

COMMANDER'S INTENT

PHASE 3 - PASSAGE OF OBSTACLE SYSTEM

PHASE 4 - MOVEMENT TO OBJECTIVE COLLINS

- MOVE AS RAPIDLY AS POSSIBLE TO PL SMASH
- DO NOT EXPECT COMMITMENT OF ATTACK HELICOPTERS PRIOR TO OPERATIONS AGAINST THE RGFC

COMMANDER'S INTENT

PHASE 5 - DESTRUCTION OF THE RGFC

PHASE 6 - DEFENSE OF NORTHERN KUWAIT

- ONCE GAINED, NEVER BREAK CONTACT WITH THE ENEMY
- BYPASS DISMOUNTED INFANTRY; DESTROY ANY HEAVY ELEMENT
- USE OUR DIRECT FIRE WEAPONS' SUPERIOR STANDOFF CAPABILITY
- PLAN TO USE CLOSE AIR SUPPORT LIKE ARTILLERY
- REFUEL OPERATIONS ARE CRITICAL; KEEP HEMMTS FULL

I-38

I said I'd talk a little about terrain. We did an awful lot of work starting last August on terrain. Gently sloping down from southwest, where we were, to northeast. I'll tell you how gentle it was, the drop in the ground was about one meter for every kilometer in travel. It was flat ground, folks. That's what it says. None of the rest of it was a problem. We did a lot of things including special operating forces that actually went in early and evaluated the terrain over which we were going to have to move. We put our vehicles of all types over the same kind of ground, etc. All things that you probably would expect to happen.

OPERATION DESERT STORM

TERRAIN

- GRAVEL PLAIN SLOPING GENTLY DOWN FROM SOUTHWEST TO NE

- SLOPES GENERALLY LESS THAN 5% EXCEPT ALONG WADIS

- NUMEROUS DRY LAKES A PROBLEM ONLY DURING RAINY SEASON

- LOOSE SAND IN CERTAIN AREAS

- WADI AL BATIN NOT AN OBSTACLE

(next slide) It's hard to visualize the weather. We actually crossed the line of departure on the 24th of February. That was about 15-16 hours early. From that time on, the weather started getting worse. If you just look at this it says 42 knots, but I think they measured some up to 60 knots. You'll see that the temperature drops and continues to drop. I don't know, I thought it was cold as hell out there personally. We had an inch of rain. The visibility was down to 100 meters. Very, very significant because when we slammed into the Tawakalna division, we found that you couldn't see much, and we had a direct firefight on our hands. At that time, we had no observed artillery fires. We had to fire based upon previously located targets and we had no air supporting us. They couldn't fly. That's the 26th.

The 27th now. The rain ended but then the fog rolled in, it was worse than if you were at sea. It was ugly. Nevertheless, at times it did burn off and the winds died down later that evening, which allowed us to bring the Apache to the battlefield and I'll tell you about the impact it had.

OPERATION DESERT STORM

WEATHER

| 26 FEB | WINDS FROM SE AT 25-42 KTS
RAIN AND THUNDERSTORMS (1" RAIN)
TEMP 14-22 C
BLOWING SAND
VISIBILITY DOWN TO 100 M
CEILINGS 200-3,000 FT |

| 27 FEB | RAIN ENDING
DENSE FOG
VISIBILITY AS LOW AS 100 M
CEILINGS TO 3,000 FT
GUSTS TO 30 KTS
11-20 C |

Diagram #2 - MSE Node Displacement

This is the route we traveled. At this point, it might be instructive to give you some comparisons. Our first move when we hit the country, the port of Dhahran, was 500 kilometers due west into the desert and operational level move we hunkered down in just flat barren ground, just about like the palm of your hand. That's what our kids went into. They thrived on it. They are tough. They are resilient. They fought magnificently, but I'm telling you they adjusted to that atmosphere much better, interestingly enough, than the Iraqis did. The 500 kilometers, for instance, from San Francisco to Los Angeles. Our next move was 200 kilometers (that's like moving from LA to San Diego) over to the west to forward assembly area butts, we went into position there 14th, through the 18th of February. The last 7th Corp units closed in on 18th February. Remember General Franks had to move just less than 40,000 vehicles when the Corps was at its peak.

Then we moved about 223 kilometers, for those of you who have been out to Fort Irwin at the National Training Center over some kinds of similar ground, from Fort Irwin to Las Vegas, and did in a little under 4 days. We did it, in the 3rd Armored Division as an example, with just over 9,000 pieces of rolling stock, 20,533 soldiers, plus 2 hospitals, 32 battalions, 10 separate companies and 6 separate detachments. This is the
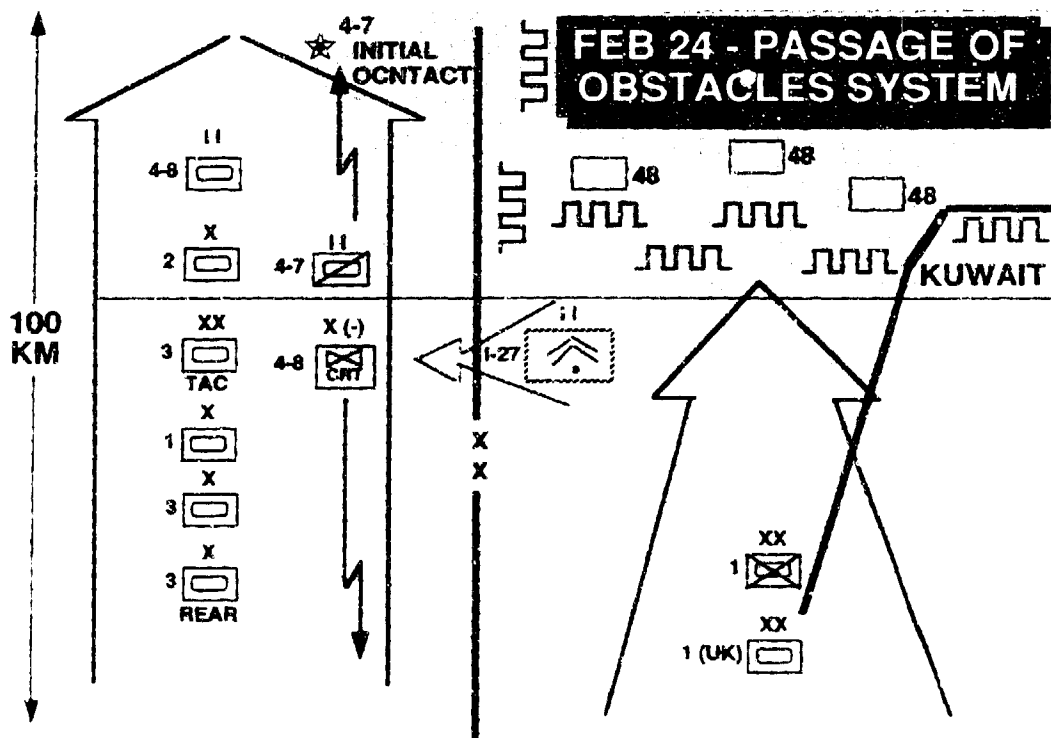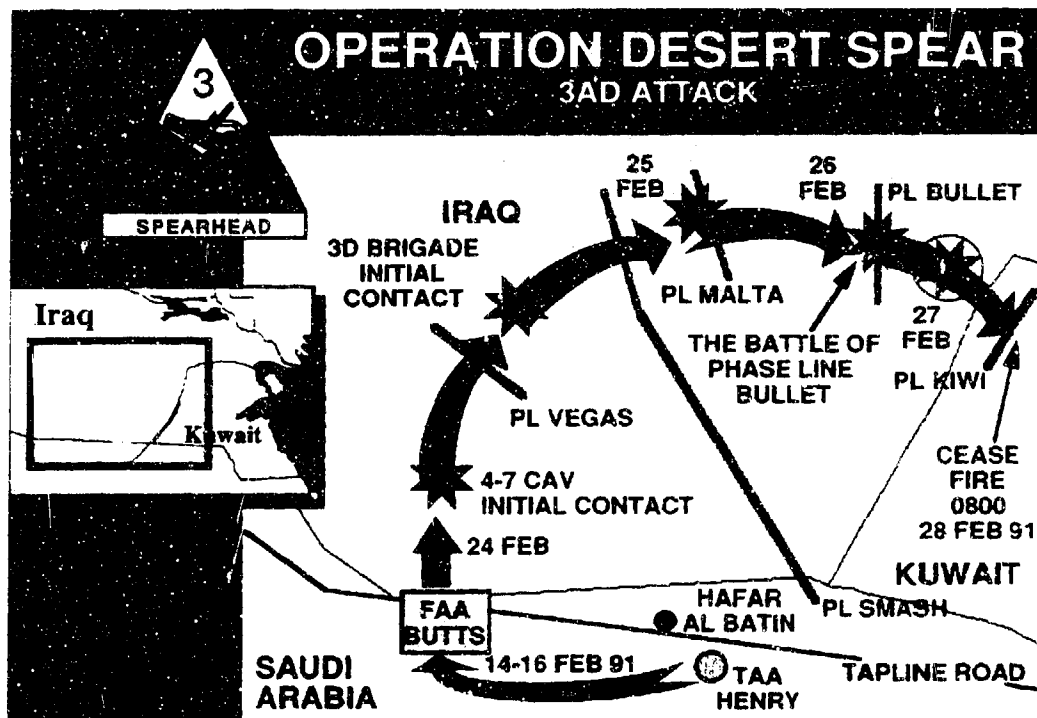
biggest armored fight ever. Just under 10,000 track vehicles (at kurse) somebody said they're just under 8,000. General Franks commanded the most powerful corps that anybody has ever put in to a war. Our divisions were built by the experience of World War II, and by the way, were finally configured just about like 86 division was. We went to the so-called army of excellence and scaled them down. General Gorman knows whereof I speak, for sure. But that's about the right size, sir, that's just about the way we fought the division.
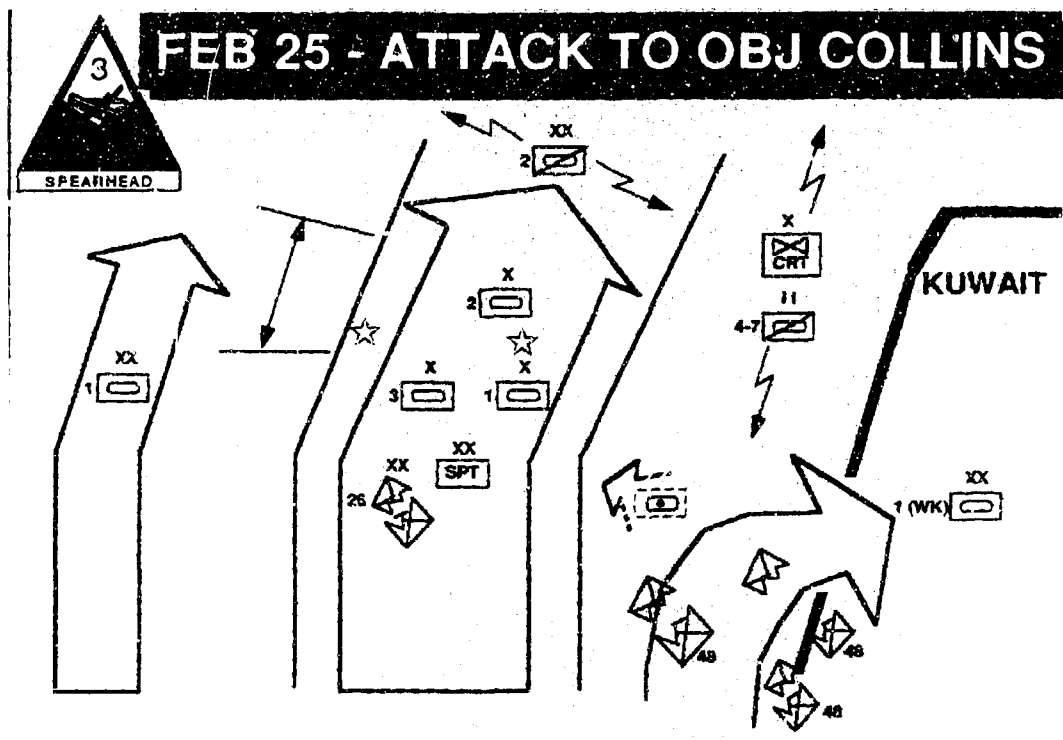
It is interesting to note this division was probably in firepower more than equivalent to a corps in World War II. So we listen to the World War II guys, we learn from it and we built a very highly mobile and flexible force. I think it's also important to point out that a U.S. Army Armored division is the most powerful division in the world. Now we've had to give up two or three of those lately, in terms of firepower, that hurts. I don't know what we're going to do with the division. My personal opinion is we ought to leave it the way it is, but there are some people, undoubtedly smarter than I am looking at that, so I hope it turns out that way. In any case, the systems that were put there, combined with the training, made these particular points on the map very important and also very significant wins for our people.

I need to talk command and control, because I think command and control really has applicability to the simulation business. It's very, very difficult for us to stretch out what we need to do in these days to really put an air/land battle corp in the field. To use the Air forces, the Army air forces, all of the Army systems and put them on the ground and then try to command and control them. I think simulation is the way to go at the joint level all the way down to the individual fighting vehicle level. I think we need to be working in that direction and I know that's what Jack Thorpe and the guys are trying to do. I lay this plan out for a couple of reasons--one, we did this and practiced it three times before we actually crossed the line of departure. You know the old saying 'Practice makes perfect," but it isn't practice only, it's perfect practice that makes perfect. That's a principle that we have to adhere to. Only when we can use systems like SIMNET time and time again, and get feedback so we can correct problem areas, only then can we get on with the business of getting better at this, which I regard as the most complex business in the world.

Fighting an air/land battle fight for a task force commander, that's a battalion he's got, probably by the time he cross attaches and everything else, 800 to 1000 soldiers, all those moving parts, and he's got to help deal with air/land battle operations. It's tremendously important that you understand the complexity of that. We built this plan, we

put the multiple subscriber equipment, we fought with that system for the first time I guess in the U.S. Army, as our primary command and control system for brigade and then all echelons above us. We changed our plan each time, we perfected it each time. We made it better. If we had simulations that we could have used in that environment, we could have done this electronically. We would have saved ourselves some wear and tear on the equipment, in fact we probably would have been even better. The interesting thing about this is, this is the way we planned it, and it's almost exactly the way it turned out. I think that's very important for you to understand that some hard work by guys like Brigadier General Gene Blackwell and the 143 Signal Battalion made a dramatic difference in this fight because if a mounted combat leader can't talk to people, he might as well go hide somewhere because he isn't doing any damn good and he's probably getting in somebody's way. The fact is, this plan worked. It was almost scary, that the whole plan worked so well and went almost according to plan throughout. Now what this really represents is a bunch of little guys and gals by the way in the Signal Battalion in little groups called nodes that are marching right behind the advance guard battalion. They're under the command of a captain, and they're racing up the desert right behind Chuck Haldman, that slow talking fellow that so understated the RPG's bouncing off the tank, and they're sticking their antenna in the ground right there and with the dozer they have with them building a berm and setting up communications within a matter of about 20 minutes. So we can then talk back to the corps commander among other things, we pass intel data. One time those great young people stretched this system 160 kilometers. Doctrines said it should go 100 kilometers, we took some chances but we had skilled people who made it stretch 160 and at that time our boss General Franks whose NRCP was talking back to Riyadh, through that system, linked in to his own corps system. This could be done in simulation and could probably be trained better. That's the point I want to make here. But I also want to make sure that you understand the great people that did this. (next slide)

OPERATION DESERT SPEAR
3AD ATTACK

IRAQ

25 FEB

26 FEB

PL BULLET

3D BRIGADE
INITIAL
CONTACT

PL MALTA

THE BATTLE OF
PHASE LINE
BULLET

27 FEB

PL KIWI

PL VEGAS

CEASE
FIRE
0800
28 FEB 91

4-7 CAV
INITIAL CONTACT

24 FEB

KUWAIT

HAFAR
AL BATIN

PL SMASH

FAA
BUTTS

SAUDI
ARABIA

14-16 FEB 91

TAA
HENRY

TAPLINE ROAD

Iraq

Kuwait

SPEARHEAD

FEB 24 - PASSAGE OF OBSTACLES SYSTEM

4-7
INITIAL
OCNTACT

4-8

2

4-7

100
KM

3 TAC

4-8 CRT

1-27

1

3

3 REAR

KUWAIT

XX
1

XX
1 (UK)

I-44

FEB 25 - ATTACK TO OBJ COLLINS

SPEARHEAD

KUWAIT

I just want to show you this one and I'm not going to go through every day of the fight. This is what we looked like when we crossed the border into Iraq. The point here is we were in a column of brigades and space is limited even in the desert. I would have been in a wedge, because that's where I wanted to fight and did finally fight in that, but at this time we're limited in space. The point I'd like to make is, it's about 12 kilometers wide and 100 kilometers long. 100 kilometers long. I couldn't communicate hardly with the tail of the convoy. I got airborne in a Blackhawk and flew...what a rush! What an exciting picture to be flying that column and looking at the great combat power spearhead division on the march, I still get goosebumps. That's what we have to convey in the simulations too, and we can do that. I'm confident we can do it. We don't have to replicate every vehicle, but we have to replicate that kind of space in time, those relationships, and if we can do that we can have better trained people in the future. We'll find out some things about the war fighting business. Great big red one over here, fight the 48th we are initial contact by 47 Cav, saw Terry Tucker on there the squadron commander. I'll tell you, we started taking prisoners almost immediately. They shot at us, we took them under fire, there were some enemy soldiers killed, and then they started giving up. That's what I

meant about how well they would fight or didn't fight. At that point, remember our goal though was to get up to see the Republican Guards.

I want to jump to the 27th now and I'm going to tell you that on the 26th, we got into the biggest fight. We were fighting all morning as the second ACR shifted to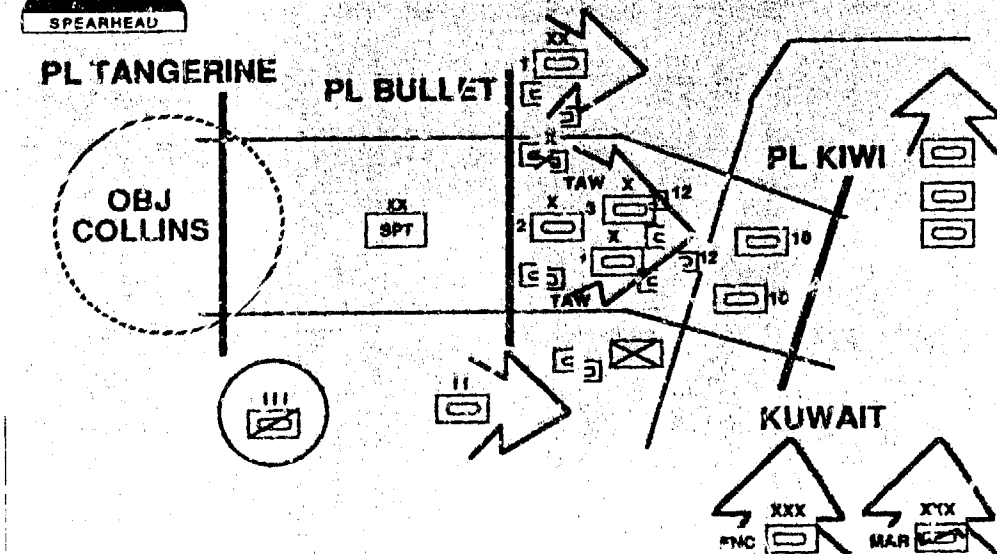 the south--you'll hear more about that later. As we pass through them, the winds came up, that lousy weather came on, and our most significant contact started at 9:45 in the morning. We'd add artillery back here and kind of brushed aside the 26th division and what was left of them, and that hadn't been much of a fight. But when we hit the Tawakalna division, we actually had two brigades of that, the 29th, and the 9th Tawakalna and all the artillery. Apparently the commander of the Tawakalna, we found out later, was also controlling the 12th Armored Division and the 10th Armored Division of the regular Iraqi Army. So in this there was a potential for somewhere around 700 tanks and all the fighting vehicles and everything else that go with them, within our sector. I'll show a little accounting of that later. The point here is that we fought hard the night of the 26th and early morning of the 27th. What happened when we started fighting was a direct firefight. As the weather started to clear and the winds died a little bit, I'd been holding the attack helicopters because I didn't feel like it was prudent to fly them very hard until we really hit the mainline Republican Guard Units. We applied them a company in each brigade sector to start with and sent them deep later. Their first combat came up here in Bob Higgin's second brigade sector right about here and at that time the Tawakalna division was fighting pretty hard, but they were being reinforced by elements of the 12th, probably a battalion from the Medina Armored Division, and also the Hamarabi Armored Division. One of those battalions was caught by the Apaches as they came diagonally across the battlefield, and at one time, that Apache company had 8 tanks and 19 bimps on fire. You could see it was very, very dramatic and made a very dramatic difference at that point in the battlefield. We fought very, very hard here. I don't want to spend a lot of time doing this, but I want you to understand that there was some extremely heavy ground combat going on up in the 7th course sector. I can't speak for anyone else, but I can tell you that the kind of fighting that went on here was very intensive.

FEB 26 - CONTINUATION OF THE ATTACK TO THE EAST

SPEAPHEAD

3

PL TANGERINE

DBJ COLLINS

KUWAIT

2 BDE INITIAL CONTACT X

SPT

4-7

1 (UK)
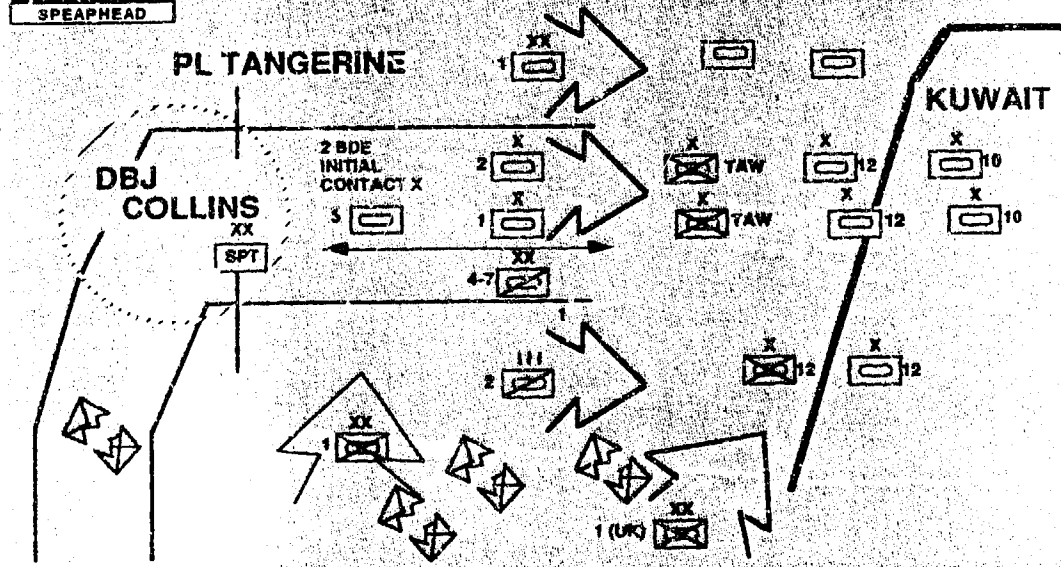
FEB 27 - DESTRUCTION OF TAWAKALNA, 12 AD & 10 AD

SPEARHEAD

3

PL TANGERINE

PL BULLET

PL KIWI

OBJ COLLINS

SPT

TAW

KUWAIT

FNC

MAR

John Kalb, Commander 4-32 Armored, talked about coming up over a little ridgeline and he was on line with his battalion. He had a tank heavy task force and as he rode up over this little gentle ridge they looked out and saw an Iraqi battalion moving again across the battlefield parallel to him. His guys on one command volleyed fire and two-thirds of that Iraq battlefield was on fire. In another volley, the rest of the battalion was dead. Now that's how quick these fights happened. You can really give credit to the conduct of firetrainer and some other things including the training system for that. I firmly believe that. What happened here was an overwhelming application of firepower by commanders at all levels particularly below the division.

MLRS--I loved that thing because it's a division commander system. It's a great weapon of terror. I will tell kind of a funny story (some of the folks who've heard me tell this will think that I'm boring because they've heard me before), the first night we were fighting the 26th we were fighting the hardest, we pulled a MLRS battery, Multiple Launch Rocket System battery, up next to the division tack. I happened to be there at the time as we're getting ready to punch on and hardly anybody knew that battery was there including me. When that battery let go and started firing as you saw on that tape, we had to have an underwear exchange here at the tack. Everybody I'm sure thought it was incoming fire and it was a moment of terror. But that's what that system did to the Iraqis. They thought it was like steel rain, and it very nearly was. Very effective on the battlefield. I don't want to go over this too much more except to tell you when these brigades fought all night long past the 3rd brigade they fought until about 2230, made it all the way to Tiwi ahead of the 1st brigade (it was fighting steady in the south). My idea was to turn the 3rd brigade south, cut these guys off and destroy them. I didn't have to, and the reason I didn't have to was by the time we got to this point on the battlefield, I sent the Apache battalion. By then we had 42 Apaches working for us and sent them deep to take out everything they could in the 10th Armored Division. They were "panging" on them pretty bad and the MLRS was flying in there--the 10th Division started to run away. They abandoned a lot of their vehicles and left them on the battlefield. Great tribute to our kids, they didn't shoot them in the back. Now some people say "yeah, you should have because they were killing their own people a week later." That's true, but that's not the way we fight.

Just a little aside, when the Mongols several centuries before sacked Baghdad, they slaughtered over 200,000 inhabitants of the city. To my knowledge, we didn't kill any civilians out there, and we saved a lot of Iraqi soldiers lives, because our infantry took the time and the trouble and very heroically swept them from the battlefield to keep them out of

harms way. This is an ethical, tough, resilient, hard-fighting army. In any case, we did fight down here in the first brigade until about 5:30 that morning when they reached Tiwi which was our limited advance, and of course cease fire took hold at 8:00 that morning local time and held. So you kind of know the rest of that story.
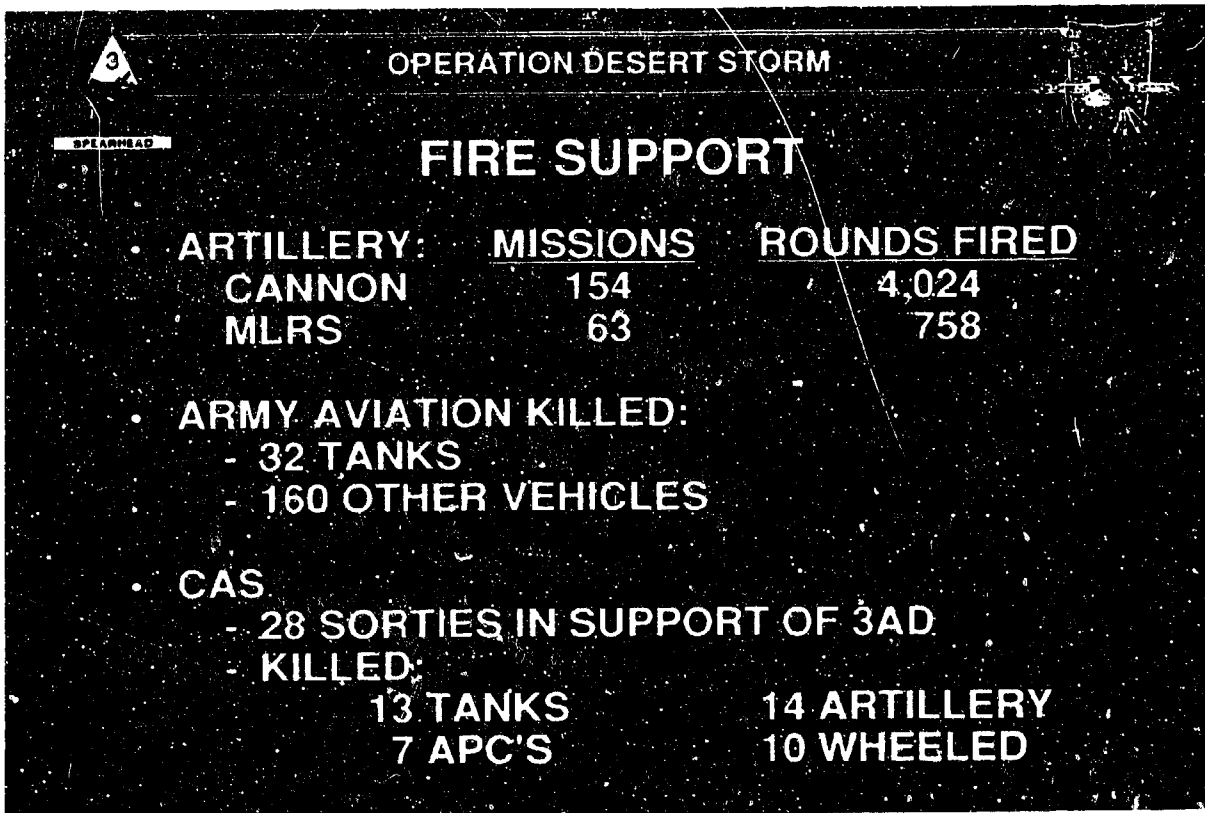
OPERATION DESERT STORM

BATTLE SUMMARY

- ATTACKED 223 KMS IN 4 DAYS
- CAPTURED 2,415 EPWs
- FIRED
    - 774 120mm TANK ROUNDS
    - 10,124 25mm ROUNDS
    - 164 HELLFIRES
    - 101 TOWS
- USED 2,114,000 GLS OF FUEL

FIRE SUPPORT

ARTILLERY:	MISSIONS	ROUNDS FIRED
CANNON	154	4,024
MLRS	63	758

- ARMY AVIATION KILLED:
  - 32 TANKS
  - 160 OTHER VEHICLES

- CAS
  - 28 SORTIES IN SUPPORT OF 3AD
  - KILLED:
    - 13 TANKS   14 ARTILLERY
    - 7 APC'S   10 WHEELED

Let me give you very quickly some numbers. (next chart) That's a quick battle summary. The MA29A1 sabot round that you heard Col. Tim Rieshall talk about in there, perfect tankers weapons some people would say...brute force, absolutely no class, fire and forget, drives a spear a mile a second, through anything that gets in its way. Here's what we could account for for sure there, I think these numbers are a little bit low. I think all the other vehicles killed were considerably greater. It was hard to tell. (next slide)

What about mission capability? These are fully mission capable systems. I just accounted for 24 Apaches, but we had 42 at the end; the other battalion that has added to us in the company was going along fine, we didn't have problems there. The only reason this number is low is because more scouts (as usual) got shot than anybody else. No tank was lost to enemy fire. There were some tanks who were still moving that were using, that had had some turret problems in these numbers, by that I mean in the 9 percent that weren't operational. I tell you, all that stuff performed very, very well for us. Here are some numbers, these are as the soldiers say "boots on the deck." These numbers I can assure you are accurate within 20 or 25 either way. This was a potential in our sector for those

tanks. This is how many the Air Forces, the BDA said they had killed beforehand, I don't know if that number is right or not, I don't really care. I will tell you that there are 374 vehicles we can account for in the division. For a total destroyed in sector (counted now by somebody's eyeballs) of about 621. I don't know what happened to the other 99, a lot of them had probably already been pulled out for maintenance, maybe some of them escaped. I had the feeling though that no tracked vehicles escaped from our sector. Same thing down here. The only thing that I'm a little bit concerned about is we got to let a little bit more artillery get away than should have. I don't know about that. I can't answer that one, but the other numbers, all these numbers, are pretty darn accurate. That's just to give you a scale.

OPERATION DESERT STORM

FINAL 3AD BATTLE DAMAGE

UNITS	INITIAL STRENGTH	DESTROYED IN AIR WAR	EQUIP LEFT	DESTROYED BY 3AD	EQUIP LEFT
TANKS:					
TAW	222	84	138		
12AD	249	104	145		
10AD	249	59	190		
TOTAL	720	247	473	374	99
APC/IFV:					
TAW	249	54	195		
12AD	177	54	123		
10AD	177	29	148		
TOTAL	603	137	466	404	62
ARTILLERY:					
TAW	90	42	48		
12AD	72	5	67		
10AD	72	20	52		
TOTAL	234	67	167	67	100

3AD OPERATIONAL READINESS RATES

WEAPON SYSTEM	ON HAND	MISSION CAPABLE	% MISSION CAPABLE
M1	368	336	91
M2	218	218	100
M3	94	80	85
M106	66	62	94
M109	120	105	88
MLRS	27	25	95
AH - 64	24	24	100
OH - 58D	6		

HISTORICAL ANALYSIS

IRAQ VULNERABILITIES

3AD PRE-WAR ANALYSIS	3AD POST WAR ANALYSIS
CENTRALIZED COMMAND AND CONTROL	POOR OFFICER AND NCO LEADERSHIP
LACK OF INITIATIVE	NO INIATIVE DEMONSTRATED
DS LEVEL MAINTENANCE	EQUIPMENT READINESS
AIR FORCE OPERATIONS	AIR FORCE INEFFECTIVE
NIGHT OPERATIONS	NIGHT OPERATIONS
STATIC DEFENSE	STATIC LINEAR DEFENSE
	NO INTELLIGENCE
	LOW SOLDIER MORALE

HISTORICAL ANALYSIS
MANEUVER (DEFENSE)

IRAQI PRINCIPLES OF THE DEFENSE	IRAQI DEFENSE EXECUTION
ALL AROUND PROTECTION	DEFENSES NOT PROPERLY ORIENTED OR 360 DEGREES FIELDS OF FIRE
MUTUALLY SUPPORTING FIRES	SQUAD, PLATOON, COMPANY, BATTALION POSITIONS NOT SUPPORTING
KNOWLEDGE OF THE ENEMY	THE IRAQI'S HAD NO TACTICAL INTELLIGENCE
PROPER USE OF RESERVES	RESERVES WERE IMPROPERLY SITED AND POORLY COMMITTED
CAMOUFLAGE AND CONCEALMENT	POOR CAMOUFLAGE OR CONCEALMENT
DEFENSE IN DEPTH	LINEAR DEFENSE
COORDINATION	LITTLE OR NO COORDINATION BETWEEN UNITS, PIECEMEAL COUNTER-ATTACKS

Now, we talked earlier and Dr. Reis mentioned this. This is our sand table. Now, if we had an electronic sand table, we could do some pretty nifty things out there in the desert. This worked, and it worked very well. This worked also, putting all this equipment on the battlefield over this ground. We wanted to make sure. This is one of our leader exercises where we took everybody down to the separate platoon level, put them out on the ground the proper distance and spread them out and stretched the communications system. We obviously doubled, tripled and above that number with some of the vehicles because we wanted to see how our weakest vehicle in this ground would act, the five thousand gallon tanker. If I had my way I wouldn't put any five thousand gallon tankers in the division, I'd make them all Himmets, give us a lot more heavy equipment transporters. Anyhow, because we did this sort of thing we knew what to expect, and we brought them along. We crossed the line of departure with one hundred and sixty (160) 5,000 gallon tanker equivalents. So we didn't run out of gas. That of course was the biggest concern in terms of resources followed by ammunition. We didn't run short of either. That's because we had good people working it and planning it.

I just showed you some of these Iraqi positions. You can tell--any of you who are veterans of NTC or other places--you don't dig positions like this--it just helps to give you away. We call them "miles piles," they will stop a miles beam, they won't stop a sabot round and in fact it just kind of shines it up when it goes through that 4 feet of sand. I assure you that it comes out the other end in just about the same shape. That's one of the real problems we have to be concerned about frankly in the identification friend or foe in fratricides. When you're intermixed as we were when this fight started the cavalry squadron was a little farther forward, second ACR was echeloned a little bit here on that flank, and the 1st Brigade was on the left of our cast squadron echeloned to the rear a little bit. We had tanks all intermixed and guys shooting at one another. Right almost 'n some cases tube to tube. That's the way it always happens in a war--it always comes down to that. When we got off at 3000 meters when the weather cleared and the conditions got better, then we absolutely had no problem. But when it's dark and it's raining and people are a little bit afraid, the tension levels will have elevated, sometimes those things happen. In any case, this did protect them from some bomb damage from the air but it also helped the close air support aircraft pick them up in the desert too. Just an example, almost all of the Soviet equipment burned. I know in 3rd Armored Division we didn't have a single vehicle that burned when it was hit by something. Not a one. That ought to tell you something about the safety built in. I'm tired of the guys that keep bitching about the M1A1 tank being 20 tons heavier than the T-72, I said, "Go ask the guys that crewed those two tanks in that desert which one they'd rather have." You can't find any T-72's crews alive. That's the truth, if they fought, they're dead. I don't say that pejoratively, I'm just telling you that tank is not very safe and it's not well protected. The number one priority for a tank when it was built and still is was survivability. It is too heavy, but we loved it out there in that desert. We loved it.

This was hit from the air before a so-called "meatball." There's a type 59, we call them 255's really a type 59, hit by a sabot round, again it burned. We found some rounds that went through one vehicle into another. Sabot rounds. I'm not sure what hit this but you can see the kind of explosion that occurred, I believe it was the hellfire. There's where we saw an awful lot of tank turrets, blown plum off. That happens to be a type 59, that's a 100 millimeter round there, I believe. There's a T-72 with a sabot hit, it did not burn, but I'm telling you a lot of them looked like this, with the turrets laying off. Even when hit by a sabot round, which you wouldn't normally think would have that effect.

I-54

Now everybody's got to have a little horse manure and gunsmoke, this is a 3rd Armored Division band playing the boys across the border. When we crossed into Iraq, the band had done such a great job we wanted to take them along and we did in their yellow school bus, and there they are. I loved the band, if anybody tries to take the bands out of the Army, we ought to just punch them out. They did great for us, played over 300 concerts in those kinds of conditions. This is typical of what the Iraqi prisoners of war said...(I can tell you one other story, we captured a battalion commander from the Republican Guard early on the first day we hit them, and the guy said "Why did you give up?" [this was at night] and he said "Well the tank on my left blew up catastrophically, and I couldn't tell where it was coming from; and the tank on my right, another T-72, blew up in the same manner, and I couldn't tell where that was coming from. I knew I was next") and so he gave up. That's exactly right. Now if I may, that's an abbreviated version but you probably got more than you cared to here anyhow.

A couple of thoughts as we kind of wind down here and then maybe some questions. First of all, General Sullivan's talking about a trough that occurs after every war we've ever fought, whether we won or lost, where things drop to a certain level of imperfection in our training and fighting business and our capability and his argument is we can't afford that anymore, and boy do I believe that. I think this technology is a way to try to keep from dropping into that trough again. I think that we're talking about some of the most complex operations in the world, even when people aren't shooting at you for real. And when you add that factor then all these crazy football analogies go out the window. If Joe Gibbs had to start with a new team every year, which is what task force commanders had to start with, if he had to deal with all kinds of rookies coming on board all the time, if he had to deal with the weather conditions that we have to go with, after you moved them for a tremendous amount of time with very little rest, and then oh, by the way, some guy's trying to kill you, not just tackle you, then you get an idea why those analogies aren't so good.

I said we had some war winning simulations; we did and I'd just like to mention some of them. For the combat forces, unit conductor/firetrainer, the platoon conductor/firetrainer, the Apache trainer, all the aircraft trainers and the Air Forces, the Navy and the Marines. SIMNET itself, and the follow-on which will be CCTT and very important, Red Flag, Top Gun. Red Flag, where I believe General Gorman first conceived the idea of the National Training Center. The National Training Center and all are CTC's are in fact simulations. Realism is what we're after. Now how do you take all of this, particularly at

I-55

the highest levels, joint task forces, in other words, joint operations and combined operations around the world and move them over all kinds of battlefields and practice that. You don't do that unless you do it electronically. We have the technology now to do that.

I'd like to make a point for the logisticians. There are no real great simulations to train logisticians. We paid for the Ukopf a long time ago, by cutting our ammunition in the tank, and the same for the Bradley. It has paid off. The fact is that we know we can fire faster on performance data and we can fire more accurately. But above all, what it helps you to do is things under degraded conditions that you could never practice in the live fire mode. Pilots can crash helicopters, which they're not allowed to do, at least on purpose, at other times. In the logistics business our two biggest problems when you put large formations in the field--transportation and supply. We can fix that, we can train that, with this kind of technology. We need somehow to put together simulators we can use immediately before the fight and even during the fight, that are transportable, easily moved around, and that can be worked by people like me, who aren't bright enough to put them together, but who know that we need to use them to prepare us. We spent because we were the last ones who'd country in our equipment, wasn't supposed to be but it was also last in a lot of it. We spent an awful lot of time on sand table exercises like the one you saw. Very helpful to us, very important to us. We were talking about really understanding the plan and we did that--that plan had seven branches--all of which we tried in our own way to simulate. We could use some help there, too. We have to support the CINCs out there. We have a tremendous problem in Europe, we can't maneuver like we used to, so consequently we need to figure out ways we can let them get very realistic training on our electronic battlefield. And finally, it seems to me that you have to fit the technology to the battlefield. You better look at the conditions, you better understand what's happening out there before you fit the battlefield to the technology. It doesn't work. Martin Vankreevald in his book, I think it's in "Command and War," talks about the really successful commanders didn't win "with technology" because the technology was great, they first understood the limitations of the technology, then, they used it to best purpose on the battlefield. I think that's still true now. The importance of fidelity, conditions and standards, and I'll use the computer guy's words "architecture" in common standards, so that all this will fit together pretty easily. Even if one outfit invents it somebody else follows along. That's very important for us in the Department of Defense in my opinion. Joe Starr used to say (another one of the guys who had so much to do with this whole effort here that I need to mention), used to say "perfection is the enemy of 'good enough,' we have to know when to stop too". Sometimes the 80 percent solution is okay. You

don't have to have a perfect tank in the Ukopf to practice gunnery skills. At some point though, you have to fire the live ammunition. But it's getting too expensive, and besides that the rounds go so far that you can't find ranges to hold them anymore. So you have to think that one through too.

What I'd like to see, and I know DARPA can handle this without a problem, is the whole 7th corps fight put in simulation. We can probably do that for next year's conference. The fact is that's the only way we're going to learn. I think it's critical to what we're doing. Our whole goal here is a disciplined, skilled, finely-honed and high-performing force, units. The Army, the Air Force, the Navy, the Marines, we all fight as part of units. Remember that team concept--we don't do that as individuals.

I was looking through one of General Gorman's papers last night, it's called "The Military Value of Training," something he did for IDA, which was very, very interesting. I thought I'd apply it a little bit here to kind of close this out. Real men and women fight wars. Not in the words he quoted in using Dupeek "Not in passive pawns, born of the musings of the library" (God, that's great) born of the musings of the library or the hacker, I guess we could say. The fact is we have to absolutely implant the human dimension here. All those soldiers have all those emotions that we possess here, and they are exponentially affected by this thing of battle by adrenalin, fear, and excitement. Now I think simulations can certainly play an ever increasing role in absolutely enhancing our performance. I know that's what all this is about. Ladies and Gentlemen, it's been great to be here today, I hope that I haven't bored you; for those who have heard me before, I apologize. But thanks very much for your attention, thanks a lot.

Jack, do we have time for a question or two?

Q: Sir, how many vehicles did you lose to fratricide?

A: (FUNK) I think with the release now, two. I think what we ought to do is focus on the ones that didn't get shot. The best technique for that will be some kind of an IFF system, probably a combination of electronic, maybe acoustic, but we have to have something. Two things that are very important here, one the real hero of this war technology-wise is a thing called the global-positioning system. If anybody thinks that you could have taken just under 40,000 vehicles and made a right angle turn within 90 degrees as General Franks did as he massed his corps, got a great way of putting it. He said, "You don't mass like this, you mass like that." Now Don and his guys are going to talk about, I think they were on about a 45 kilometer front down there for awhile. Let me tell you when

we massed the 3rd Armored Division we were on an 18 kilometer front. That's mass, we had some momentum behind us. GPS, very, very important to us. And it doesn't have to cost all that much. I remember when it was the number one position locating system, the number one priority in TRADOC way back in General Gorman's days that was true. To answer the question on IFF we just simply have to get better at that. You heard me talk about the direct control of direct fires. That's one way. We can train that very well with these kinds of systems. But we have to have a better recognition signal, nothing worked very well. I'd be glad to talk to you separately about that, too.

Q: Can you talk about the role of deception operations in your planning?

A: (FUNK) Yes. I think deception properly belongs at the highest level. In this case central command had a deception plan, it worked very well. Everybody in the Iraqi Army thought the Marines were going to land on the coast. But they didn't, tied up probably two to four divisions. The deception of keeping all of the force east of the Wadi Al Batin, making it appear that we would not attack except directly into Kuwait itself, was in my opinion a brilliant deception and worked very, very well. They didn't understand that we could move that quickly in about 4 days time, 200 kilometers in the case of 7th corps, 350 kilometers I believe out to the left flank of the 18th corps. They never believed we could move like that. I think we surprised the guy strategically. Saddam Hussein never believed that we would attack him, neither did his Generals. Secondly, operationally, by the moves we made due west into that desert in that period of time without losing hardly any equipment. I said we moved 223 kilometers from the line departure to the limited advance. But the real point is we had already moved just about 5 days before that another 200 kilometers. If you were at the end of that thing, you were moving from San Diego to Las Vegas. We dropped hardly any equipment. All of that played in the deception. The third area is the 1st battalion commander we captured of the Republican Guards, it literally said, "Where did you guys come from? We thought you were at least 5 or 6 hours away." When you have five or six hours at the tactical level, five or six hours of time ahead of the enemy, you absolutely have surprised him. All of those things deception played a role, and a very key role in this. But it has got to start at the top, and the plan has to be tied together as it goes down. Not a lot of people have to know about it, but it better be tied together or you'll find yourself coming and going.

Q: From a commander's perspective will you discuss lessons learned and coordinating close air support?

A: (FUNK) A lot of people are working the whole "lessons learned" bit, and I've been cautioned not to say too much about it. We can get better, if we do this electronically, if we practice it more. I think it's a very, very important aspect that's been fitted into the technology demonstrator at Fort Knox and at Fort Rucker and other places. The fact is we have to get better at that, we have to get quicker. Now remember this didn't last all that long, and so unlike Vietnam, we didn't have a lot of time to practice all those skills. The people that came to us as part of the Air Force package were terrific. We worked very well together. But there are still some problems with definitions, like the fire support coordination line that I won't go into now, but trust me, we've got to keep working that business together with our friends in the Air Force. Good question. All of them are.

Q: Did they fight their doctrine?

A: (FUNK) Very good question. In fact, we started in August looking at the Iraqi doctrine. The short answer is no. They were set up to fight their doctrine, their plans were written, we captured a plan--I didn't have time to show you all this--we compared before the war and after the war and asked the jeep to go back. One, we said what are his vulnerabilities, and two, how did that turn out after the war? One, he didn't follow his doctrine. Just a short example, in many cases, his overlay showed interlocking fires, in other words, mutual support between platoons, then of course between companies, and finally between task forces and even brigades. The fact is he was on the ground all spread out, so very seldom did he have mutual support except in some cases, few cases amongst platoons. The other classic example is the use of reverse slope positions and tactical fighting. The idea is to catch the enemy as he tops the military crest, right, at the max effective range of your weapons, say 1000 to 1200 meters with a T-72 or any of his other tanks. We found them in reverse slope positions, but they were about 300 meters from the military crest. What that meant was if you had the proper mass and came over the hill and fired first you could kill him before he could take you under fire. And that's exactly what happened. His doctrine is kind of an amalgamation of Soviet and British doctrine which he just didn't follow. His plans were drawn very well by the way, those that we captured. They had a good feel for that and understood that. It was implementation, and let me tell you I can find no record of them doing any extensive training from August onward. Now once the bombing campaign started you wouldn't expect them to be out on the ground doing a lot of running around. The Air Force...that's kind of an unsung part of the Air Force, but as far as I'm concerned for a ground commander it's one of the most important parts. It made him spread out, and made him hunker down. They got a bunker mentality.

Never mind whether or not they killed all the tanks or anything else, that didn't matter nearly as much. We can kill the tanks and we did it. But they did even more important things in that regard. So that's a long way around your question, but the fact is they didn't train to their doctrine beforehand even when they had the opportunity. We ought to learn a lesson from that one, folks.

Q: Sir, a lot has been said about intelligence...

A: (FUNK) In fact, I of course didn't get into the strategic business and wouldn't presume to, but at the tactical level what we need is a lot more rapid transmission of pictures. The best example I can give you, there are guys in the Pentagon looking into fox holes and counting the number of rounds of ammunition in them. But we didn't have that kind of information in a timely manner, for task force commanders and below. So this is a communications problem; we have the capability to take pictures like that and make images like that, we need to be able to transmit them much more quickly because our time is of the essence to us. If it's last weeks photos it doesn't make a damn for us. We're talking now that the division on a 24- to 72-hour basis, with the task force you're talking two hours. We got to find something maybe a UAV to fly to the hill, look around, I don't know, I'll let somebody else figure that out. But there's a requirement for that. The second thing in that regard is that we have to have something to sort all that kind of stuff so that we get the right information to the right people at the right time. General Storey in particular worked a long time on that, that's a toughy. There were all kinds of things available to us. We just need to do better in getting it to people and I think we can do that. I know that's being worked.

Q: How much would a serious jamming effort have affected your operation?

A: (FUNK) I think that's a good point--we thought--in fact they had some very good jamming equipment which you probably know. They didn't use it much but they were scared to death to turn on their systems. One of the real problems they had was that the Air Force kind of weaned them. Early in the war every time they turned on something that emanated a lot they got a HARM down the tube or something like that. That's another kind of unsung sort of a thing that you hear about. In fact, I don't think that jamming would have overly affected us. And I'll tell you why, and I'm talking the tactical level. The reason is that we had practiced this many times, our commanders knew what our intent was and also what General Frank's intent was and frankly I knew what General Schwarzkopf and General Yeosock's intents were. So the fact is that we could prepare

those kinds of things that cut down the radio traffic and it also allowed us to proceed even in the time when we couldn't communicate well. We didn't have to face that...you're quite right and it is a threat. I do not believe it is as serious as the Soviet capabilities are, and I'll tell you that we've overestimated that a bit. Nevertheless, we better think about it. OK? Thanks very much, folks.

--73 EASTING--

BACKGROUND AND OBJECTIVE

Colonel Jack Thorpe, USAF
Defense Advanced Research Projects Agency

COLONEL JACK THORPE

I would like to describe the goals and purposes of the conference, the objectives of the research itself and some technical background. The proposed agenda will be changed if we need to change it for some particular reason and go in a particular direction. I need to stress this is a working conference and what you're going to see is the work in progress. Of those of you who came to see something finished, it's not done yet and the intention to do this conference this early in midcourse is to expose the community to what we think is a pretty good idea and very interesting technical idea and have you give us feedback and look to how we might work together. The skeleton is about 90 percent complete and what we'll do now is to really start to hang the muscle on it.

* **Purpose of this conference**

* **Objective of the project**

* **Background**

* **Agenda for next 3 days**

1

PURPOSE OF THIS CONFERENCE

- **Describe a technology application**

- **Share methodological lessons learned**

- **Get new ideas, critiques, mid-course suggestions**

- **Discuss problems, limitations, potential applications**

- **Discuss data sharing**

- **Help launch similar reconstructions**

2

N xt slide please. What I'd really like to get done at this conference is to allow the researchers that have been performing the work to describe the work they've been doing, report of you lessons learned to date and solicit your critiques, ideas and suggestions for any mid course corrections. They'll tell you what is going on as planned, what hasn't gone as planned and what we've learned as we've done it. We'd like to share with you ideas of what we think are potential applications, because what we think are those applications are shape where we take the technology; discuss means of sharing data with the research community. For those who would like to try something similar in general it is suggested that doing all of the 7th corps battles would be something similar. For your organization's firest technology compelling or offshoots, or variations of it, I think we would like to share any of the things that we've learned to help you along if you'd like that kind of assistance. Let's figure out just exactly how to do that.

THE OBJECTIVE OF THIS PROJECT

> **Use interactive simulation technology to construct a detailed record of a real battle**

1. CAN IT BE DONE?
2. WHAT ARE THE PROBLEMS?
3. WHAT ARE THE PAYOFFS?
4. HOW CAN IT BE DONE BETTER?

3

Next slide please. We are attempting to use a specific technology, that of interactive simulation technology, to construct an accurate, detailed account of a real battle. At issue is whether this is possible to do in the first place, how difficult is it, what is it good for and how can we improve the process, should we do it a second time, how can we make it better?

POTENTIAL APPLICATIONS

- **Military Training and Education**

- **Requirements Definition, Development & Acquisition**

- **Readiness**

- **Operations**

4

Next slide. There are some pretty obvious technical applications as shown on this chart and I would be remiss if I didn't tell you that at this point we think it is possible to do what was stated on the previous chart. So what are the payoffs, what do you target? This perhaps--the first bullet--is the more obvious. Military training and education. A precise reenactment of historical event in interactive simulation becomes sort of a living history book, if you will. One can imagine all the different ways you can use that kind of interactive media. You can imagine the young cadet at the academy being shown first hand in sort of a living environment, a particular battle and a lesson that he should learn from that battle, as he's taking classes. If it's truly interactive you can imagine inserting him in that battle and allowing him to try his hand at command. That's really tough to do and we've been thinking quite a lot about how to do that. I hope that by Thursday noon several of you have been thinking a lot about how you do that and share some of those ideas with us. You can change the attributes of the recorded battle and modify those with unacceptable limits. You can't change the battle, you can't change history to some absurd level but if you can change it within common sense limits and then study the outcomes, then you have an extraordinarily powerful tool to try to understand what we should develop and build and

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how we should build it and how we should then train for its insertion into the force and from a readiness standpoint, how you actually then train people to use it. So important, as General Funk told you this morning. And finally for readiness and operations if this metaphor of the electronic sand table can hold and can hold for things that we're trying to do on the 73 Easting Project, then we have an extraordinarily powerful tool for allowing a commander to convey his intent to those in his unit that have to go out and fight and follow his plan of operation and for those hours when you return from the battle and are trying to figure out what occurred so that you can do better the next day the same thing that we're doing for 73 Easting months after the battle. One can imagine doing for 73 Easting of the future hours after the battle.

SELECTION OF THE PROTOTYPE BATTLE

- Narrow window of opportunity

- The Battle:
  - Bounded in space and time
  - Battlefield accessible for survey
  - Leaders and troops available

5

Next slide please...Why did we pick 73 Easting? This project got started with a handshake from the director of DARPA who addressed you earlier today and the chief of staff of the U.S. Army, General Gordon Sullivan, in late March. It was absolutely by accident, by coincidence, that we were in his office and we started to get first hand reports of the battles that were coming out of the ground war and we're talking to the chief about simulation and we started to speculate, gee whiz, I wonder if we could reconstruct in our simulation system one of these battles. It took everybody about a nanosecond to suddenly realize that was a damned good idea and we ought to try it and the gentleman who sat up here a little while ago, Vic Reis, said I'll pay for it. I'll cancel something else, I'll redirect some money immediately and we'll put a target team together. A few weeks later we had a team in concrete collecting the data. So we pretty much had to seize the opportunity, figure out what battles we could try, which were available when and we just had a few criteria for the selection; one, it pretty much needed to have a start, a middle and an ending and that couldn't be too long. Number two, we needed to walk the terrain, we needed to go where the battle was and look at the firing positions and look at where the TOL missile lines went from those firing positions and see where the opponent vehicles were headed and try to

understand what went on in that battle. Third, we had to have, if at all possible, the leaders and troops that fought that battle right there on the same battlefield so that they could explain and we could capture what they did. Given those criteria, we worked real fast and made a pretty fast decision and picked among a score, matter of fact, several dozen possible battles all good, good battles, all professionally fought and we picked the battle that is now popularly known as 73 Easting.

73 EASTING

- **2nd Armored Cavalry Regiment**

- **Afternoon of 26 Feb moving from 60 to 73 Easting**

Offensive Covering Force → Movement to Contact → Hasty Attack

vs.

Heavy Brigade in Deliberate Defense

- **Weather conditions restricted Air Force and Navy close air support; limited Army aviation**

6

Next slide. As you have learned, this was fought by three troops of the second armored cavalry regiment. As they were involved in an offensive covering force moving to contact and then conducting a hasty attack against heavy brigade, a republican guard dug in in a deliberate defense. You will learn as General Funk has already shown you some examples, it was done on a pretty lousy day. The weather was bad, strong winds, very dark sky, and this battle that we focused on took place in the late afternoon. As such, there were very few truly combined arms if you include any kind of aviation, in this particular battle We would have like it to be a great model, panacea, of full military systems and services but that was not the one we eventually focused on for this initial prototype and perhaps that kind of battle will be the type that somewhere in this audience there is the follow-on to this project.

IF IT IS POSSIBLE....

- Takes advantage of simulation technology to:
  - Play back in real time, view from any angle
    - = *Undergraduate Time Travel*
  - Retain full dynamics
  - Manipulate battle attributes within limitations
    - = *Graduate Time Travel*

- Requires an unprecedented amount of detail and precision

7

Next slide. I discussed somewhat earlier in my introductory comments that if you can use interactive simulation technology to capture a battle such as this, then you can do all the things that we do routinely when we run a battle in simulation, that is, we can play it back, we can move around the battlefield, dog eye view anywhere we want, even places where people weren't and we can stop time, move back, move forward, do all kinds of things, get inside tanks, look and see what gunners were looking at all those kinds of things. And we have been calling that for a long time among the research community, undergraduate time travel. You don't change history, that's the definition here for us, the inside definition. Undergraduate time travel like all of us when we grew up, you always talked that if you were a time traveller you were not permitted to go back in time to change history. So that's the undergraduate level. If you can in fact manipulate the battle attributes, within these limitations of common sense, we call that now graduate time travel. That is where you can actually go back and change some attribute of the battle and see in fact what has occurred. To do this precisely requires an unprecedented amount of detail and precision.

GENERIC ARCHITECTURE OF INTERACTIVE SIMULATION SYSTEM

MANNED SIMULATORS

NETWORK

Update Messages

Semi-Automated Forces

Flying Carpet

LOGGER

UPDATE MESSAGES

- Precise Position of All Objects
- Special Appearances & Behaviors
- Event Outcomes

Complete Information Set of everything that has happened on the battlefield in the form of messages
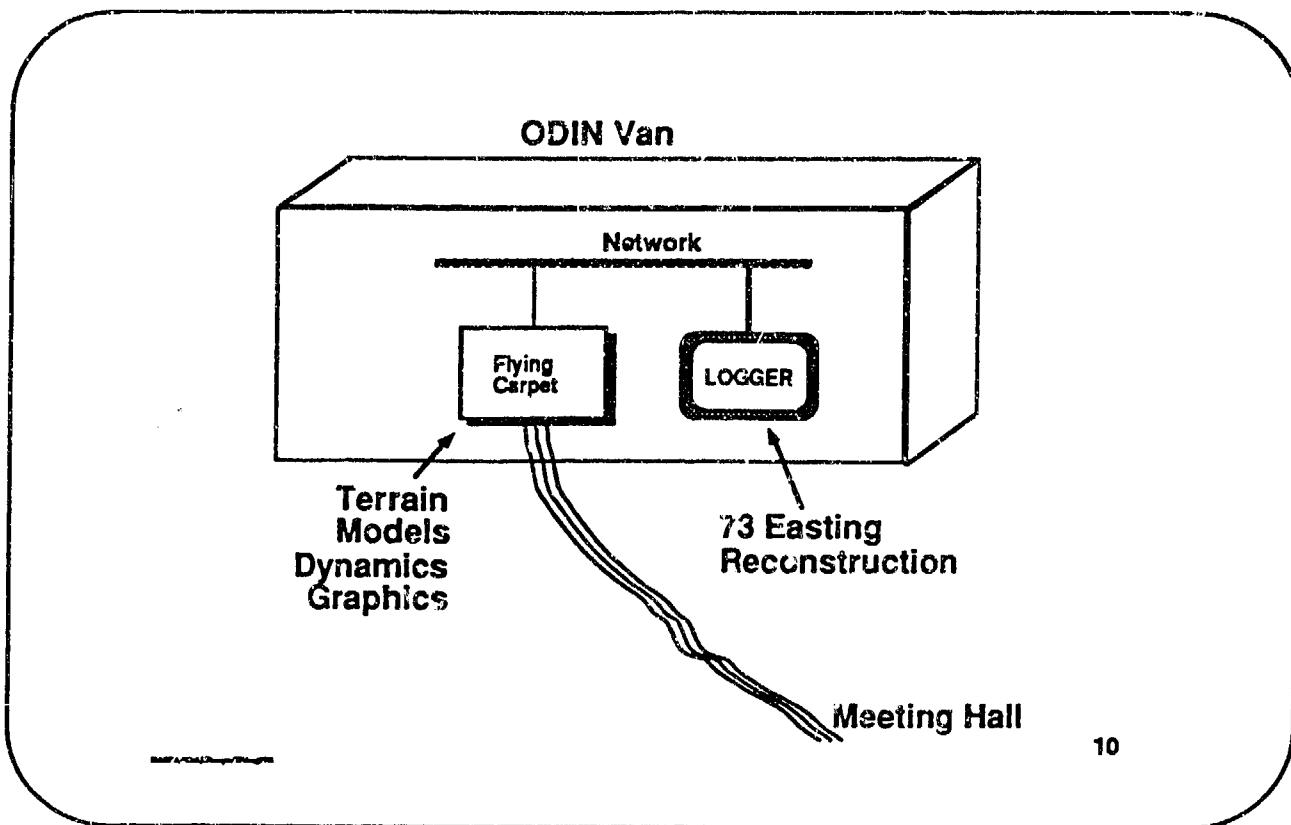
Time Stamped & Recorded

8
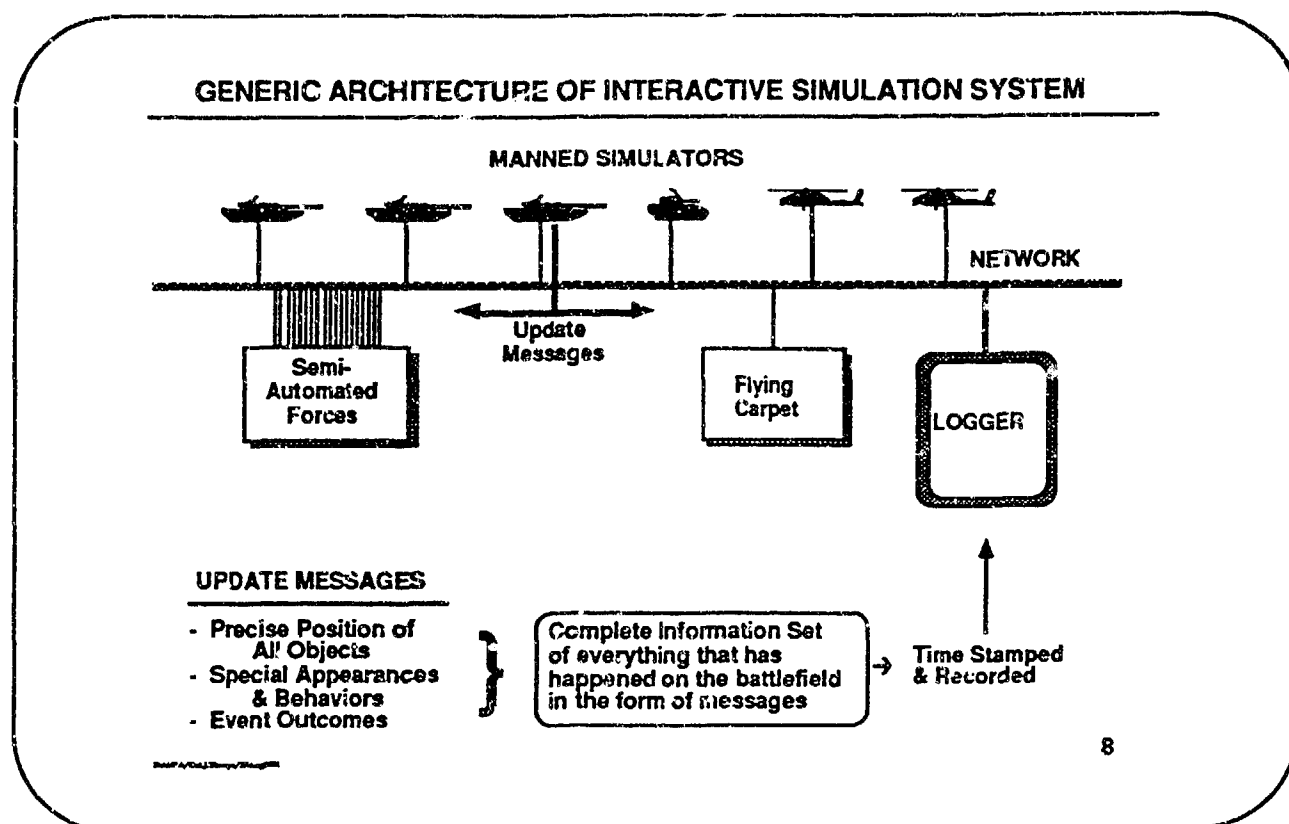
Next slide please, and we will illustrate why that is. If you use generic interactive simulation, basically how that kind of technology works is that you have all the simulation devices that are plugged into a network sending messages to one another about what they're doing, sometimes, many times a second. In these messages are the precise information about their location, how they look, what they're doing, and any unique event outcomes. And given that every simulator starts with detailed data base of the terrain and a complete data base of the library of all the things one finds on the terrain. Given that, you can now re-create exactly everything that is going on in that simulated battle. As a matter of fact, we routinely collect all of that stuff, time stamp it and record on a data log which is just a digital recording device that's collecting all the messages all the independent simulation elements are sending between each other. If we use this approach in reconstructing an actual battle that means we have to behave as if each of the combat vehicles in that real battle were simulators sending information among themselves to keep the world straight. Maybe several times per second depending upon what they were doing. That means you really have to reconstruct with great accuracy everything that was going on.

I-73

THE FLYING CARPET

- **2 - D   (Plan View Display)**
  - **Digitized map**
  - **Teleport**

- **3 - D   (Out the Window)**

  - **Unattached - Constant above ground level**
  - **Unattached - Free fly**

  - **Attached to a specific object**
    - **Tether**
    - **Orbit**
    - **Compass**
    - **Mimic Commander**
    - **Mimic Gunner**

Next slide please. If you can do that then you can now use this thing called a flying carpet to go back and examine what has occurred, and that's what we have here. As I talked about that this morning there are a few different modes the flying carpet has. Any of you that has looked at the workstation has already seen those. One is this two-dimensional plan view display. A map view that allows you to look top down and see the location of all the various combatants as the battle progresses. The second is the three-dimensional display, the out-the-window display, which is a means of visualizing what is going on in three-dimension. Just like the commander saw it. Our out-the-window display allows you to have several different ways to attach to vehicles and you will see that this afternoon. We can go out, pick a vehicle, attach to it and tether to it or tether around it or always look in a particular direction no matter which way it turns but still being tethered to it, if you will. Get inside it as the commander's view or even as the gunner's view. Or you can remain unattached and free fly around the battlefield. Either like a magic helicopter or with some specific connection to the ground above ground-level view.

ODIN Van

Network

Flying Carpet

LOGGER

Terrain
Models
Dynamics
Graphics

73 Easting
Reconstruction

Meeting Hall

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Next slide. In the programs we've been working out at DARPA we have a number of these flying carpets that are typically installed at simulator sites. We have also put one in a van and that's what's parked out through the back door. How you find that is you go out into the hall and you see a bunch of black cables, follow the black cables and you'll get out to the van. In the van which was developed under a project called ODIN, which Commander Dennis McBride will talk to you about during this conference, we have one of these data loggers. A playback device that can take a real simulation that was recorded or a reconstruction of the 73 Easting battle play it back, allow the flying carpet to visualize it, present it and then with these remote devices, we could observe it. I was going to show you some more demo of what we showed earlier today but right after me are the fellows that will actually show you some of the 73 Easting simulation as they have constructed it. I'm going to let them do that at this point.

From Dr. Jesse Orlansky, 'DA:

- Carefully reconstructed ground truth
- Precise information on positions, time, firing events, target kills, radio traffic during battle
- Valid data base, reviewed by participants

The Medium

- Visual representation of events
    - Plan view display (2-D map)
    - Out the window (3-D)
- Not a videotape
- Not a simulation

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Next slide. Jesse Orlansky, on Thursday morning, will talk to you about his view of what you do with this kind of technology. I'm not going to steal his thunder here, but as an analyst he points out the bottom two bullets. So what you've seen is not a videotape, when we play an actual battle back and what you see is not a simulation--it in fact is, to the best of any one's ability to reconstruct, it is the most precise reconstruction, dynamic reconstruction, reenactment of the battle that is possible.

CLASSES OF SOURCE DATA

Anchor Points	Known data verified in	- Time - Location - Event - Sequence - Person/Unit
Extrapolated	Enhanced by Observer Reports	
Extrapolated	Deduced	
Unknown	Completely Ambiguous	

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Next slide. The fellows that follow me immediately will talk about data collection. They won't talk this afternoon, what they're going to do is describe the battle. Tomorrow morning when they tell you how they are actually reconstructing the battle, they'll talk about the data that they've collected. It's in roughly four categories. There are some things that we know for sure. I call these anchor points, where we actually know the time of something, its location, or what occurred, or the sequence of the events, or who did it. Sometimes you know a combination of these things and sometimes you know only one of these things. You also know that two things occurred and something occurred between those two things and you can go and you might not have the absolute data on those things but the guys who were there can describe to you that they were moving at a particular speed and this happened or that happened so you can fill in between those anchor points. Sometimes you have two events that you know absolutely occurred but you don't know exactly what happened and some deduction or imprint is required and some things in the reconstruction, nobody knows what occurred. So, there is something that has to be filled in there. The fellows you will talk to tomorrow morning will tell you how they've been handling these classes and sources of data. To try to understand that and to try to understand how each of these things fits together is one of the hardest parts of this kind of reconstruction.

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Next slide. So how are we going to handle the next couple of days? This afternoon, we are going to ask three fellows to talk about the actual battle. General Funk, this morning, talked about the battle that was taking place behind and to the north of this particular battle. The 73 Easting battle took a context of the 2nd ACR and so Colonel Mike Krause from the Center of Military History, now the chief of logistics with the 22nd support command in Dhahran, will come up and introduce the group and talk about the overall view. As a historian, he will present this kind of information as a historian would traditionally present this. Tomorrow morning and following thereafter Major Doug Lute--who was the regiment operations officer--the S3 will give you the regiment picture. Colonel Bloedorn from IDA will talk to you about the specifics of the battle. Tomorrow morning we will have a team that had been actually constructing the simulation tell you how they have been going about their business, and will continue into the early afternoon. Then we have a senior officer panel. Fellows that have been past war fighting CINCS, have substantial experience using data similar to what we're talking about here and we have invited them to give their analysis and observations. Thursday morning a bunch of fellows are coming that actually are analysts that have to use data like this to make decisions on a

project-by-project basis and we've asked them to consider how you might use this kind of reconstruction in their typical analytical business. I need to mention that a large number of people have been involved in this project even though it has only been going on a few months. We've had folks from the Pentagon, from General Keller in Army training, PM Trade, they train project manager training devices in the Army, and aviation schools and centers have been participating, data collection and analyses performed by IDA and the Office of Military History, and ETL. Just a number of folks on the government side have been involved. We have had contractors that have been helpful, kind of doing some of the major part of the work; Bolt, Beranek and Newman in Cambridge and Bellevue, Washington, working on the simulation, construction of simulation of software, and Illusion Engineering in California doing analysis of data, and that's roughly what the roles have been. So by way of introduction let me now introduce Colonel Mike Krause and have him start with the description of the battle situation.

DESIRED OUTCOMES

- Constructive evaluation of the approach

- Suggestions and ideas

- Plan for data sharing

- Assistance to those who would like to do other Desert Storm battles

- Ideas on better ways to collect future battle data

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--73 EASTING--

PRESENTATION OF THE
73 EASTING BATTLE

Colonel Michael D. Krause, USA
Office of the Chief of Military History

COLONEL MICHAEL D. KRAUSE

Thank you, Jack. It is a delight to be here all the way from Dhahran, Saudi Arabia, serving what I call a logistical sabbatical in the Southwest Asia Theater of Operations.

Let me try to do three things this afternoon, after literally catching my breath from a long-distance trip.

Could I have the first chart. This is a picture of the desert. This type of ground is flat. But it is deceiving. Here one meter rise over one kilometer of ground can make the difference between life and death. You have obviously seen some of the pictures of the ground, here and on TV. Others have experienced it first hand. You have also heard the description of Major General Funk on what this conflict was all about.

I will try to do three things:

First, to give a quick commercial on methodology; second, to give an overview of what the fight was all about; and third, to offer some observations/conclusions that we--the team here--what conclusions we have on the state of the effort.

Let me also introduce the team. Major Doug Lute was the 2nd Armored Cavalry Regiment's Operations Officer (S-3). We policed him up in the desert. Presently, this British Army Camberley educated officer serves as the Chief of Staff's speech writer. He will give you the actual conduct of the 2ACR operation. Another lead member of the team is Colonel (Retired) Gary Bloedorn. Former director of the Armor school training development, he is one of the key inventors of the simulation training methodology we used to document the battle. He will give you a detailed review of the actual methodology in the simulation.

Let me start simply by echoing the words of the British historian, Sir Louis Napier: "We are at a turning point in history, where history may fail to turn." World events unfolding before our eyes may not turn history the way history is supposed to turn. For the historian's craft there is now a change in methodology where we may fail to turn. We may not appreciate it and grasp it soon enough. This methodology is the advanced distributed simulation methodology. This methodology which we will see here as the reality of the desert captured data that we historians would take millions of words to describe. In a very silly way I could say: "There is so much data out there--so little time."

But with computerization inherent in this simulation methodology, we historians can capture the data and use it. Hence, I think the methodology used here, what the historian's craft is exposed to, is extremely important. Next point on methodology. Let me become quite personal. I am an immigrant. I came over to this country, getting off the boat some years ago. So I'll be quite Kissingernarian about this. Kissinger always started with a heavy duty quote, and I've selected an appropriate German historian, Leopold von Ranke by name. He founded the scientific school of historians. His credo was captured in this phrase, "Geschichte ist wie es eigentlich gewesen wahr," or "History as it actually was." Hence our question here today is one of methodology of capturing the actuality of this battle: 73 Easting.

How do you capture history "as it actually was?" You conduct documentary searches. That is what we historians are comfortable with. We are now, however, at a turning point in historical methodology. Documents I would offer are not only the written records, but they are also the computerized records, the telephone conversations, the recorded radio traffic and personal tape recorders, the message traffic, the oral interviews, the recorded after-action reviews--some on TV tape, the collective, recorded interview. In short, it is the actuality of the event. It is also participant reconstruction of the event on site. And this is what our on-site team did in the Iraqi desert. We used all the modern techniques of documenting the event including reconstruction using the Global Positioning System to be absolutely terrain accurate. Lest you think that battlefield, engagement reconstruction of events is new, we did this after our Civil War. Admittedly it took 20 or 30 years to do. But we got old veterans to go back and tell us, now here is where the artillery was positioned and this is where we charged from and this was our exact position according to our field engineer, etc. So from a methodological point of view, I would begin my defense of this new methodology by stating that this methodology re-creates history "as it actually was."

The then Vice Chief of Staff, General Sullivan, sent us--the team you will meet today and during these proceedings--to the desert to capture an engagement--battle--determine whether it had operational significance, and then document it. Capture it, search it out, do everything you can to ensure that, objectively speaking, this fight is recorded for our history. And make no mistake about it: This was a hellatious fight.

This then is our purpose: To make sure in these series of roll-up your sleeves working sessions that we talk methodology. My bottom line is from the historian's view

point we are in the avant garde of methodology and we captured the event "as it actually was."

There is an intrinsic resistance on the part of a historian toward the acceptance of change, particularly the acceptance of chang on how the actuality of this type of conflict gets recorded historically. I would offer the thought, having stood in front of fellow military historians, that we as a group are not very accepting of changes in the historical medium. We are now on the threshold of being able to create what I call a living history book, an electronic staff ride.

Let me analogize by taking you back in time to a more comfortable 500 years ago. We historians are like the monks, scribing before 1490, before Gutenberg came around and invented the printing press. We are now so dedicated to the written record and printed word. Yet we must see change coming. We are now capable of producing a "living-electronic-history book," as seen in this simulation methodology. Perhaps we can see in computers calling up visual images, and thereby learn better and faster through use of additional senses. Computers have not yet figured out the sense of smell, fear, anxiety and all of these kinds of blood and guts associated with battle, that we saw and experienced this morning. So to conclude my first point, put very simply, we are at a turning point in history, in its methodological consideration. Documents, the written record, the oral, the on-site data is all here, and we'll have a chance to talk about it and experience it.

If I could have the next chart. Point two. This is the theater of operations and here is the strategic view. As an aside, I did promise my boss, LTG Pagonis, the theater logistical commander, that I'd mention logistics at this gathering. But let me be serious about having you understand the concept that logistics made possible, the campaign. Some folks have called it the logistics miracle in the desert. Stated in those terms you might just remember these first in our military history. First time to get two corps into an austere theater with the immense materiel required over large distance. The first time we crossed or flip flopped two corps in our modern military history and moving them the immense distances of 300-400 miles, which MG Funk mentioned this morning. Then only being able to use two main supply routes. Constructing logistical bases in front of our corps, this is an unheralded concept. Here is the logistical effort that moved two corps in 21 critical days. Hereby this meant heavy transporters passing a given point, one every minute, every hour, 24 hours a day, for 21 days to move and sustain these two corps. And now, hold your breath, not doing this so the enemy can see it. If Hussein had seen this logistical
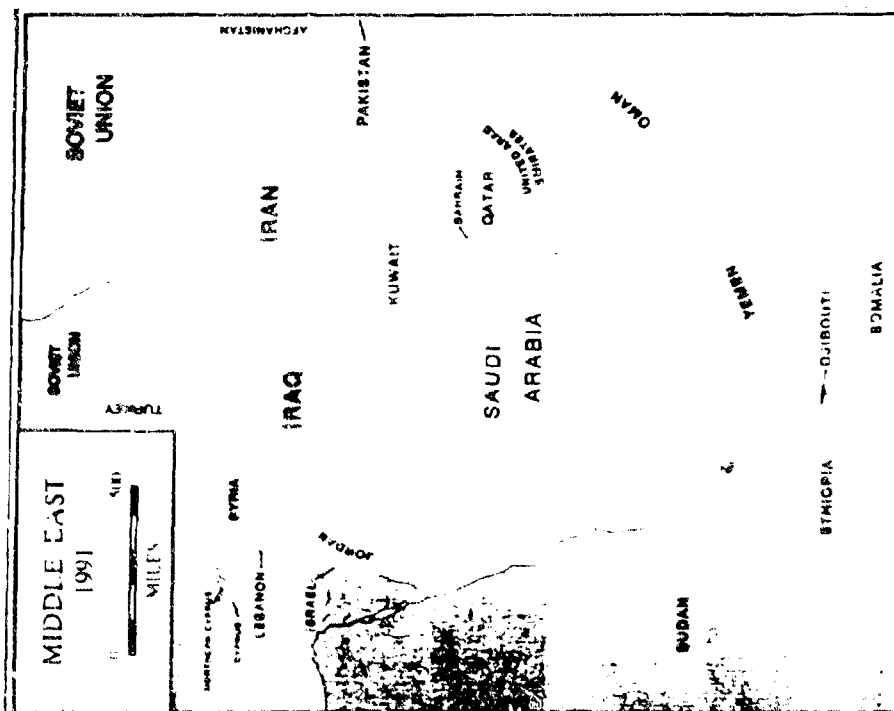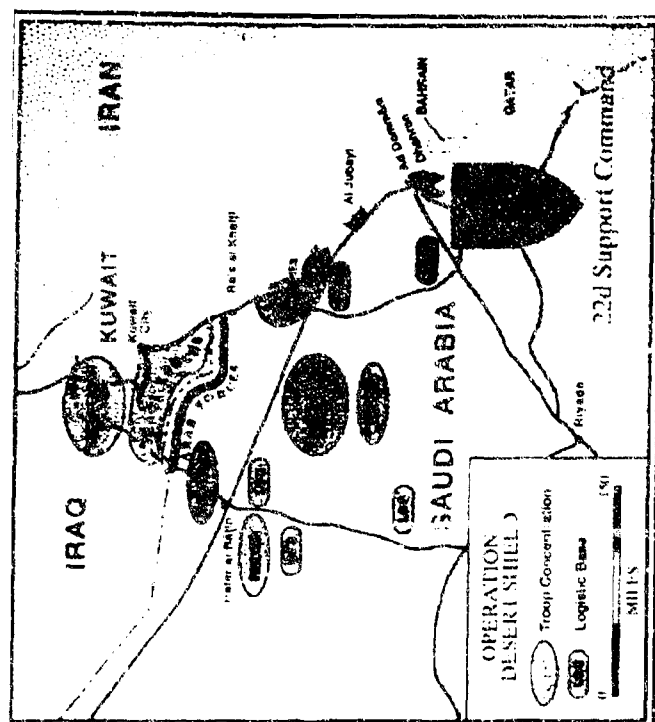
Logistical Support Structure

Theater of Operations

build up, he would not have been deceived about our left hook or "Hail Mary" play. In short, don't let the enemy see that you're moving two corps 300 miles to the west! What an achievement.

Next chart. This is the campaign. It shows the movement of corps and divisions in phases. Let me orient you. Persian Gulf, Saudi Arabia, here is the northern Saudi border which had a berm; Kuwait and the various units associated with the campaign.

Let me ask you to remember General Colin Powell's news conference in January 1991. He walked out to an audience similar to this one and said about our campaign plan, simply "We are going to cut it off and kill it." Obviously he did not show this map! Obviously he didn't tell Saddam he would be blinded by the air campaign. Next, etched in our memory is the General Schwarzkopf news conference wherein he explained the end run--the left hook--through the desert. This then shows the forces arrayed, having moved 300-400 kilometers westward. Then you see here the deployed corps, the XVII Airborne Corps to the west and the VII Armored corps to the east. You see them flip-flopped, they were deployed in reverse. This has never been done before, not with this kind of an armor heavy force. You are literally talking about field army equivalents. Then bring out the coalition forces of French, British, both actually incorporated in the two corps and the Arab coalition and other allied forces, including the Marines deployed here to the east directly opposite Kuwait. Here then, you see the fast-paced attack delivery of the 18th Airborne Corps and its assault into the southwestern portion of Iraq. Saddam Hussein would have done well if he'd paid attention to Colin Powell's words in the news conference: "Cut it off and kill it." This then was surprise, lightning speed, this was deception; the enemy was fooled into thinking we would not come through the western desert. This was maneuver, underwritten with massive logistical support. This was the campaign plan that General Schwarzkopf operationalized. He held to this campaign plan which attacked the Iraqi Republican Guard as the operational center of gravity. Here you see the VII corps breaching the berm with the First Infantry Division. Parenthetically, why a berm? The Saudis constructed it before the war essentially to keep smugglers out and control vehicular traffic. From a military viewpoint, this defended berm obviously carried tank forces through an exposed position and had to be bulldozed away with breaches constructed through which the attacking forces could pass. Here is the planned attack. 2ACR in the lead, followed by 1AD, 3AD, then 1ID and 1AD (UK) with 1CD attacking up the Wadi Al Batin. All this was well rehearsed and planned. General Schwarzkopf gave LTG Franks, the VII corps commander, the mission to destroy the Republican Guard.

OPERATION DESERT STORM
24-28 February 1991

I-89

Let me turn to the VII Corps commander's concept of operations. I'll ask you to remember what MG Funk showed you in the film this morning, the divisional sandbox used for the explanation of his concept of operations. Our team stood with General Franks in a similar sandbox in Iraq. It was in this sandbox that LTG Franks explained his concept of operations. Let me re-create this for you. Standing in the sandbox, laid out with string and pins, were the various divisional boundaries and phase lines which were used to control the four days of attack. He stepped us through that concept so that we understood it. We could see it unfolding. The two armored divisions were led by the 2ACR as a covering force, with its mission of find, fix and develop the situation for the corps fight against the Republican Guard. The 2ACR commander--now a Brigadier General-- Don Holder, wrote the doctrine which was used. LTG Franks trained and employed the force which used the doctrine. So the setting is the sandbox with the corps commander standing there articulating the concept of operations and describing the unfolding of the plan. Short descriptive sentences ring in my ear. "Mike," he said, "The plan was to outflank him--Saddam Hussein. It was working. Elements of his force were deployed to the south against the 1CD. Iraqi forces were deployed against our most westward forces. We were now deep in Iraq. On 25 February at 0841 I ordered 1AD to shift northward and pass the 2ACR. 3AD was still behind 2ACR at this time. Early in the morning on 26 February at 0216, I gave a frag order to orient the force to the east. This meant the passing of the 3AD to the north between the 1AD and the 2ACR. By 0918 26 February the force was arrayed as follows: 1AD in the north--here on the map--the 2ACR and then the 3AD. With 1AD (UK) followed by 1ID here."

Having set the stage for the battle of 73 Easting, General Franks continued. "Mike...a classic cavalry action: find, fix and fight, but not too closely. Cavalry's job is to set the stage for the corps fight." Then General Franks continued his explanation of the movement of the Republican Guard Tawakalna Division. "The Tawakalna was moving southwestward. It was screened by the 12th Armored Division. The Tawakalna was followed by the Medina and Hammurabi. Moving southwest on an asphalt road called the Ipsa pipeline road. (Inexplicably this road did not show on the maps of the 2ACR. This road would be right about here on your map. Now we know that the Engineer Topographic Laboratory maps showed the road. These maps were provided, but were probably stuck somewhere between national intelligence level and the guy on the ground It was this road upon which the Tawakalna Division was orienting.) "If we had been 12 hours later, his force would have been better prepared. But his guys knew this terrain after all this was their Hohenfels." Let me emphasize General Franks' staccato phrase

"Classic cavalry mission, find, fix, and set the fight so that I could pass the armored divisions into the battle."

General Franks spoke of clenching his fist of combat power and destroying the Republican Guard divisions. To be able to do that, he had to find the Tawakalna. This division was armed with the most modern Soviet export tank--the T-72 model. Other regular divisions were equipped with older Soviet models, usually the T-55 and 62 series. Hence, once the 2ACR through its air cavalry scout reports reported T-72 tanks, it oriented towards this force. This would then be reported to the corps commander.

Next slide. I won't detail the movement of the regiment because Major Doug Lute will do that next. I'll just give you an overview. Notice the 2ACR was acting as an offensive covering force. Here are the phase lines. You might notice the phase lines are named Sharps, Beck, Bud, Busch, Colt. I should tell you that cavalrymen get thirsty and it is awfully dry in the desert. Doug will tell more of this story!
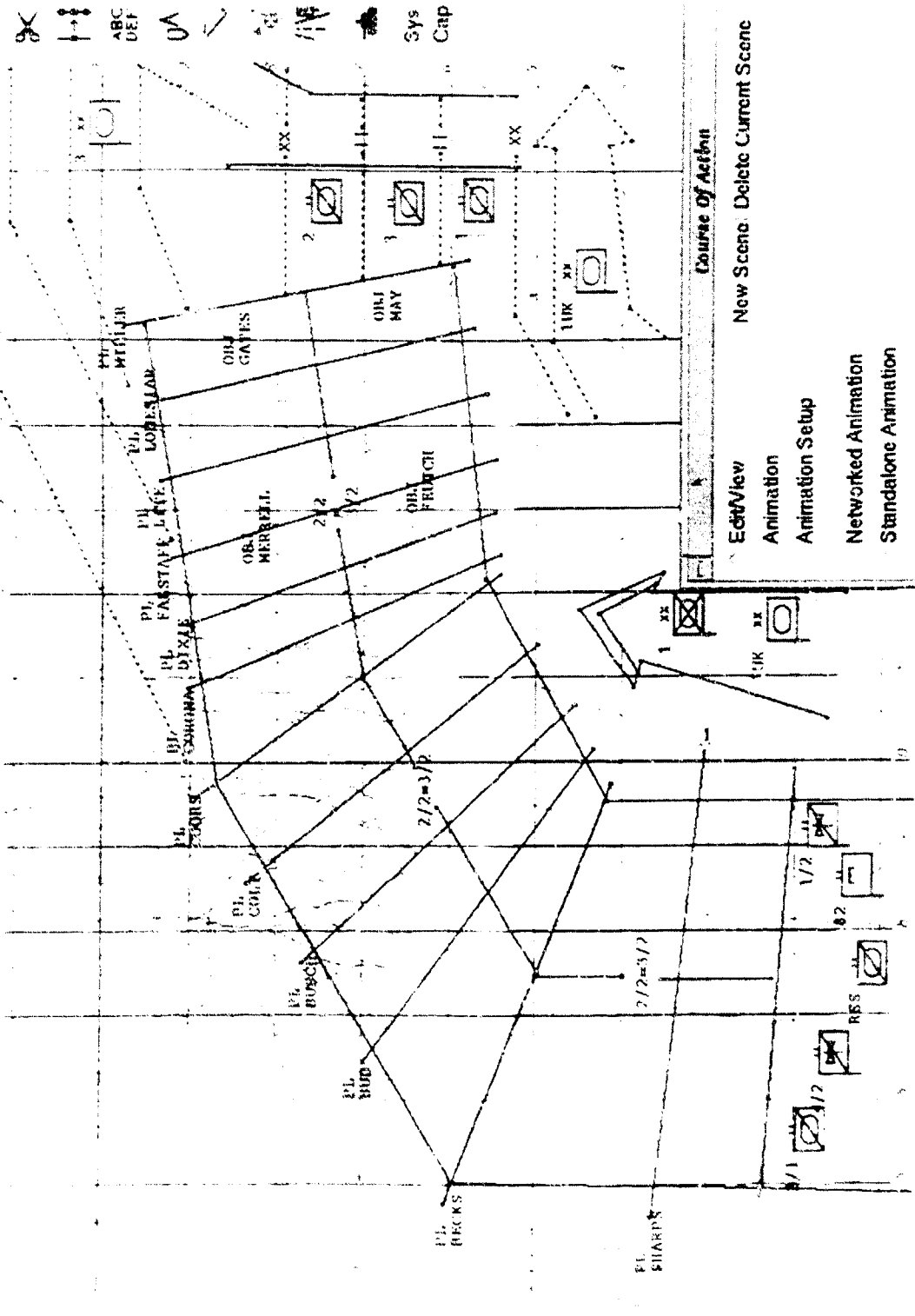
This was not just a calvary regiment. It was reinforced with lots of artillery, engineers, helicopter squadrons and even a psychological warfare unit. Doug will detail the tailoring of this regiment.

To conclude my sandbox rendition of General Franks' concept of operations, he suggested the key importance of finding the Tawakalna and then passing the 1ID through the cavalry regiment. This is not an easy thing to do, to pass a division through a cavalry regiment engaged in battle. General Franks then said 'Go take my helicopter, my track and the commanders and find out how they did it." This fight held operational significance because it determined the course of battle. We will see that in some detail. The regiment set the terms for battle for the corps. Don Holder's action is therefore key.

Without detailing how everyone got through the berm, the 2ACR led northward leading the 1AD and 3AD until about the 58th Easting. (An Easting is a north-south grid line on a map.) Here the 2ACR began to receive reports of the massing of a brigade of the 12th Iraqi Armored Division as lead elements of the Republican Guard force moving southwest. General Franks met with Colonel Holder and held an assessment.

Next chart. Here you see the regiment. Because of the limitation of time, we could only focus on three troops of the regiment, rather than the whole regiment. So you need to keep this in mind as we focus on the fight. It was regimental in scope, but we will only detail the three troops you see on the map here. From north to south is the 3AD, then 2nd

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■ Grids ■ Roads ■ Buildings ■ Powerlines ■ Pipelines
■ Water Trees ■ Railroads Boundaries Contours

Squadron, then 3rd Squadron, with Ghost, Eagle, and Iron, respectively. Here you see the beginning of the battle from about the 60th Easting when one of the troops is taken under fire. Here, then, we will show you what the commanders did at all levels. How they reacted and how quickly this action takes place, much longer than it took to document it.

Next chart. Here Gary Bloedorn will detail Ghost Troop commander Captain Joe Sartiano fight. What is interesting is the seam between the 3AD here to the north and Joe's own fight firing into 3AD sector. Between 2nd and 3rd Squadron personalities become important on this seam. Because the Eagle troop commander, Captain H.R. McMasters, and the Iron Troop commander, Captain Dan Miller, were West Point roommates and classmates, they both were used to the other getting on each others command nets to make sure they knew where each others units were. I won't step you through each of these boxes for Ghost, Eagle, and Iron. Each of these fights will be detailed for you this afternoon using the electronic maps.

Let me just tell you in 82 hours the Regiment covered over 200 miles in the desert, fought elements of five divisions, conducting covering force operations for three divisions of the VIIth Corps. The Regiment integrated CAS with ground maneuver and operational fires to destroy the security forces of the enemy. The Regiment fixed and disabled the Tawakalna division and developed the situation for the Corps commander.

The Regiment fought in some of the worst weather conditions imaginable. MG Funk gave you the weather report earlier this morning. That's 200 meters from this room to the courtyard where you can't see, sometimes opening to 1400 meters. You've got to shoot because you're being shot at, sand is in your face because the wind is blowing at 40 mph, adrenaline is secreting and pumping in your veins now, and I'm gonna get shot up right now is going through your mind. Worst visibility you can speak of. Here are some of your effects: Over 300 Iraqi armored vehicles destroyed, over 2000 enemy prisoners of war captured, with losses to the Regiment of 6 soldiers killed, 17 wounded, 4 Bradleys and 2 APC113's destroyed. The entire action and philosophy is captured by Colonel Holder's very succinct phrase "The regiment is always ready: all brothers are brave." All of them fought, not just these three troops.

Now let me conclude with my point three on observations and conclusions. I've given you an overview of the corps and regimental fight. Make no mistake about it. The intensity of an Eagle troop action of 23 minutes of going through a mine field, to come up

on a ridge line, to be taken under fire from a village and a whole host of T72's--don't think this was a cakewalk. Don't think this was anything less than a fight. Artillery fire at this time, silenced by helicopter air from Apaches flying in these terrible conditions from LTC John Ward's 2nd Aviation Battalion of the 1AD. This is a coordinated fight between three troops here and all other troops of the Regiment, all mutually supporting. There is no hesitation to press the attack when going through a mine field, when you hear mines exploding, and Captain McMaster literally uses the words of General Jackson engaged in the turning movement at Chancellorsville: "Press on, press on, and move through, attack." This is raw action. Amazing discipline. If you can imagine all of a sudden shooting to kill those tanks and BMPs and at another point dismounting and taking enemy prisoners of war and treating wounded. That is an amazing discipline of the American fighting soldier which may not come across in all of the data points that we have collected. Here also is the performance of our equipment. Amazing ranges, first shot kill at 3450 meters. Bradleys used effectively to pin-point targets behind berms and by simply setting them afire as General Gorman has already indicated. Soldiers used the simple, effective rule "If it ain't burning, it ain't killed." There was total reliance on global positioning system in tracking through the desert. Our soldiers were fond of their equipment! Can you imagine being fond of your equipment--sure you can if your life depends on it!

There are a whole host of observations on the connectivity of small engagements having operational significance. We may want to talk about this and how it can be used in the simulation. The second observation on the turning point within the historical profession.

This book--this "living electronic history book"--needs to be written. It is a book that will use the documentary record which we have sought to establish in experimental usage here. It will allow us to use the oral and computer date technique to interrogate the Captain McMasters and, say, you could not have been going 25 kilometers an hour in this attack. Data tracing shows you could only have been going 10-15 kilometers per hour because of sensitivity analysis that was done based on the documentary data.

Well there are lots of additional things we can get into as we roll up our sleeves. There are lots of questions between the seams of historians adjusting to technological change. That is what this is all about. Let me close by suggesting the reality of the fight was captured as it actually was. I believe this process means a great deal for our Army in training and education. It is a good marriage between history and computer technology

which will improve training and education in our Army. It relives a fight and allows us to use it. Now, I welcome your questions, but in the interest of time, I better allow Major Doug Lute to tell you the Regimental story in detail.

THE BATTLE OF 73 EASTING:
THE REGIMENT'S PERSPECTIVE

Major Douglas Lute, USA
Office of the Chief of Staff, U.S. Army

MAJOR DOUGLAS LUTE

Let me start with a couple of disclaimers. First, when we named the phase lines after American beers as Colonel Krause mentioned, it was only to serve as an enticement for the young cavalrymen to continue up the axis of march and I never thought I would be up in front of a couple of hundred people trying to explain all that. It was an innocent cavalry trick out in the desert and I never thought anybody would care. But, here we are. My purpose today is well explained by one of Colonel Krause's slides so I'm going to steal it, if I may. (Colonel Krause's slide of entire campaign using unit patches to show movement of units) What I'm going to do is take you inside this symbol of my unit (the shoulder patch of the 2nd ACR) and trace the unit's progress from our last position in Saudi Arabia, to where we crossed the benm and then to our leading VII Corps on its portion of the "left hook."

We prefer left hook, not "hail mary." Hail mary implies to me: "Gee, can we really do this?" It's usually the last play in a football game when you throw the ball up for grabs. That is not what this was, in my view. This was rehearsed, practiced. It took 15 years of dedication and hard work by many people, many of whom are sitting out there, to be able to pull this off. It was anything but a last ditch effort.

My purpose today is to try to bridge the gap between the strategic and operational perspectives that COL Krause has set for us and what is to come later this afternoon. I'm sure everyone is waiting for those monitors to come to life. I want to bridge that gap between what's already happened and what we are all waiting for before cocktail hour--the simulation, itself. And I'll do that by following that shoulder patch along the course of the left hook.

I should tell you that I'm a stand-in. My former boss, now Brigadier General Don Holder, was unable to accept the invitation to be here today. It's a rare opportunity for an operations officer to actually give one of his own briefings. So I'm a little at a loss for words here. You always write these things and then somebody else gets up there and tries to get through. Let me see if I can do as well as I always hope my boss does. I do hope that this meets General Holder's standards. Let's go to the first two slides. (Slides 1 and 2 simultaneously. Slide 1-2ACR Graphics, Slide 2- Organization of Briefing)
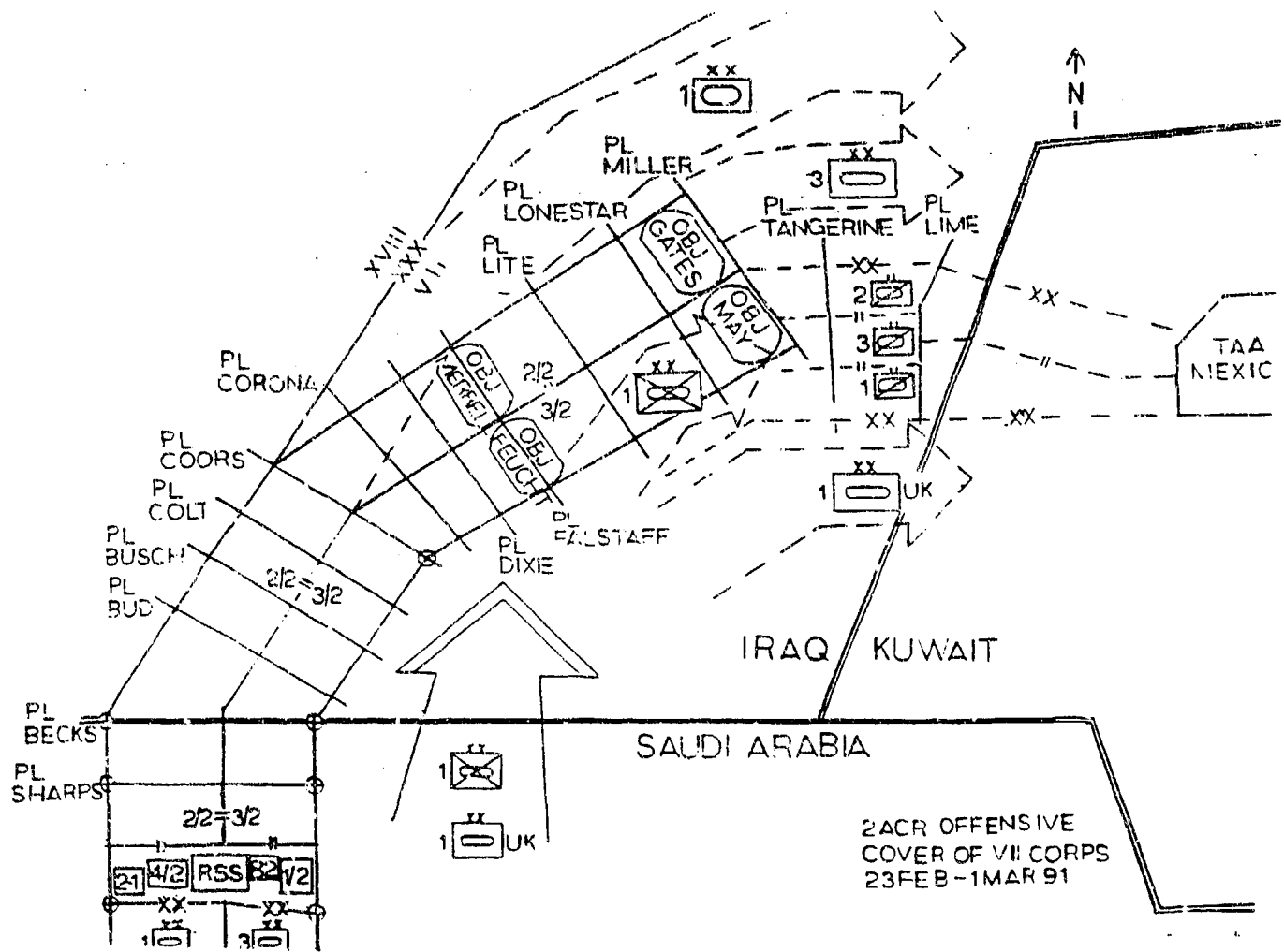
2ACR OPN DESERT STORM

ORGANIZATION

✔ MISSION, TERRAIN, ENEMY, TROOPS

✔ CONCEPT OF THE OPERATION

✔ OPERATION SUMMARY

1-100

OPERATION DESERT STORM
24–28 February 1991

Allied Advance, Phase 1
Allied Advance, Phase 2
Allied Advance, Phase 3
Allied Advance, Phase 4

MILES
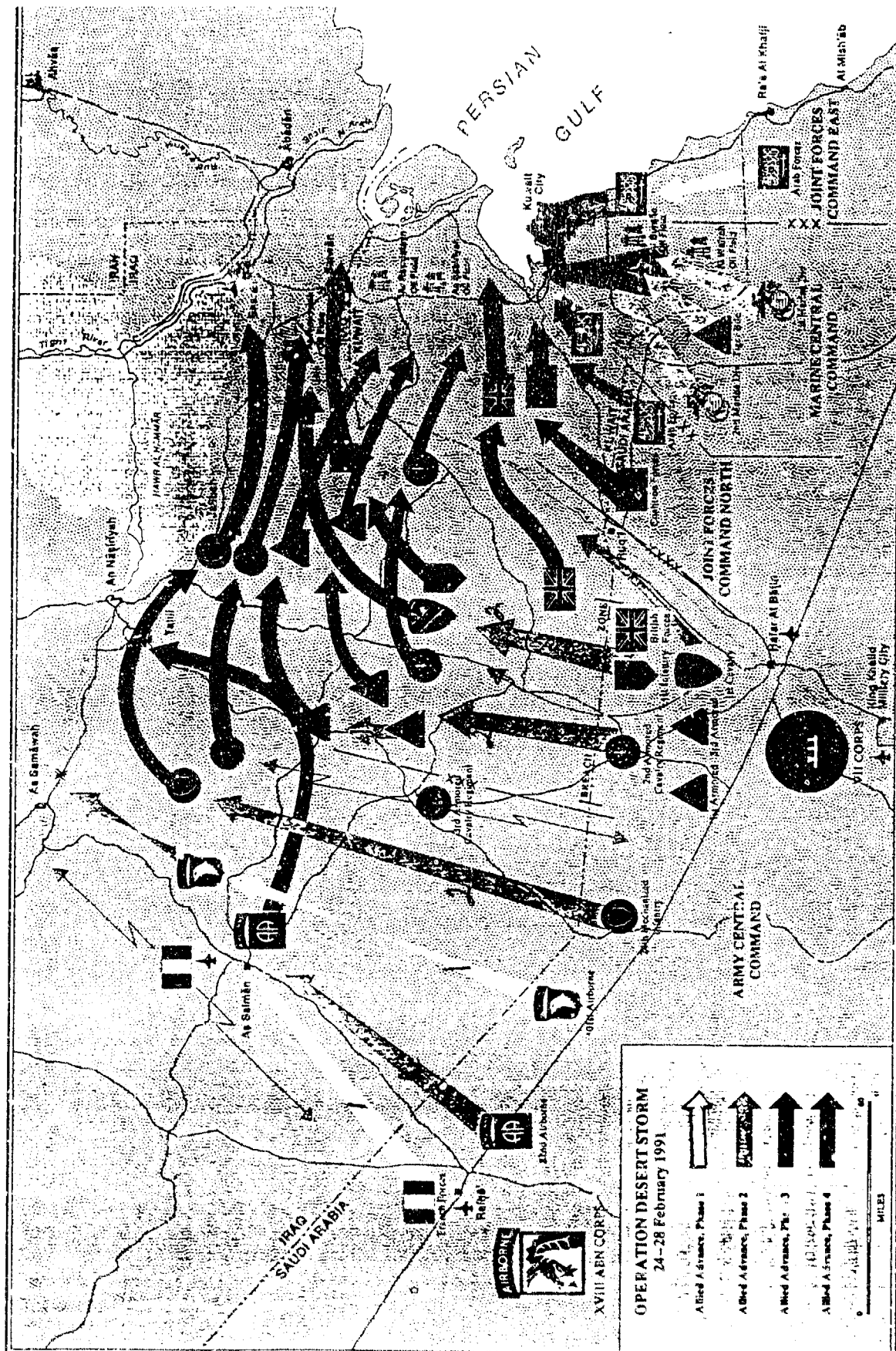
Any good briefing informs the audience as to what is going to be covered   I'm going to go inside the shoulder patch; look at the mission, the terrain, the enemy (though a little more detailed than you've heard, focusing on the Tawakalna Division), the troops available (that is, what made up the Regiment), our concept of the operation (what it was that brought us out in front of the corps, how we fit into the corps picture), and then finally give you a brief operational summary. Some of this Colonel Krause has covered and I'll skim through. I'll leave this projected on your left (slide 1) throughout the briefing and change these slides on the right so that you can use this as a touchstone and try to keep yourselves oriented.

Let me walk you through this (slide 1) in a bit more detail. This is 19th Century technology, a straight edge ruler in the back of a truck in Saudi Arabia. But, maybe it's effective. Here you have what we call the tri-zonal point or the tri-state area. It's very important because it orients you to the three countries involved: Kuwait over here, Saudi Arabia down here, this is the famous border berm, and Iraq up here. This essentially takes you along the Regimental axis in our mission in front of VII Corps from just south of the border here and all the way up. This portion of the graphics (around the 73 Easting battle) has become familiar to you by now. All the way up here is where we touched the Tawakalna and the battle took place about here.

The meaning of 73 Easting should be clear. An easting is nothing more than a straight line that runs on military grid maps from north to south. And because they progress from east to west, they are called eastings.

The reason why we called this battle the 73 Easting is that there is no terrain out there; so you can't call it the battle of dry gulch or something, because there is no terrain. As we gave fragmentary orders to the unit we simply told them to move to a particular easting or northing within their boundaries. The reason for that is that they could turn on their global positioning system devices, index where they were headed and the device would essentially navigate them across featureless terrain. So that's why the battle ended up being named with an easting. Many people in the Regiment didn't know what an Easting was before this because we never used them. But we do now.

Again, let me orient you: this axis is the Regiment's, this line (the Regiment's left) is the boundary between XVIII Airborne Corps and VII Corps. Immediately on the right over here, there should be another line which indicates the right boundary of VII Corps. The Egyptian corps attacked here, in the flat of the Kuwait border. So it was the Arab Corps, led by the Egyptians, then VII Corps and then XVIII Corps way out on the left.

Within VII Corps let me set the stage. The Regiment was positioned here initially, with two divisions behind us: 1st Armored Division here (in the west) and 3rd Armored Division here (in the east). So we were covering, we were in front of, those two armored divisions. To our right was the Corps' main effort initially, which was the penetration attack by the 1st Infantry Division out of Fort Riley, Kansas, and they were followed immediately by the 1st British Armored Division. So this was a coalition corps--it had allied forces or formations in it. This was the main attack; that is indicated by this double arrow.

Q: Sir, how far across that map?

A: About 200 kilometers--120 miles to 130 miles--perhaps a little more when you get out here. This gives you some idea: the Regimental axis is 45 kilometers wide, which is somewhere between 25 and 30 miles.

The Iraqi defenses ended about here. At that point Saddam had run out of conscript infantry, he had mobilized just about everybody, and by the way, the air campaign had started, which meant that he couldn't afford to continue to truck people out farther to the west because they were under air attack. So it's no mistake that the Regiment's axis is just beyond that front line defense.

It was a classic envelopment attack. One form of attack in American doctrine is envelopment. That's what this was. We went around the corner of the defense. I'll talk to you a little bit more about the Regiment's role but essentially our aim was to lead the heavy hitting combat power of VII Corps, which were these two armored divisions, lead them up and introduce them into combat with the Iraqi center of gravity, the Republican Guards Corps, at a time and place of General Frank's choosing. So when we say "set the terms of battle" we mean we want to put the armored divisions where you can do the most good. That was the Regiment's role. Colonel Holder, the Regimental Commander, reported directly to General Franks. And two Major Generals, the division commanders, listened very carefully, they waited for the flag to drop which was the commitment of that division by the corps commander. So that's how the chain of command worked in the operation.

Next slide (Slide 3-Mission). This is right out of the Regimental operations order. Let me try to interpret it a little for you. Two covering missions, initially a defensive cover, because we were stationary here south of the border for some time, about a week, which is longer than we wanted to be that close to the border and just sitting there quitely. But initially we covered here, south of the border. That transitioned then into an offensive

covering force mission, which means essentially, we moved out. And again, we stayed between the Corps main body, which were those two armored divisions, and the Iraqis. That's the Regiment's job.

MISSION

ON ORDER, 2ACR COVERS THE WESTERN FLANK OF VII CORPS AS IT OCCUPIES FAA UTAH. ON G+1, 2ACR ATTACKS THROUGH THE WESTERN FLANK OF ENEMY DEFENSES AND CONDUCTS OFFENSIVE COVER OPERATIONS IN ORDER TO DEVELOP THE SITUATION FOR VII CORPS.

G+1 is one day after the initiation of ground hostilities. That was the plan. As it turned out we went on G-day because the Marines had such success over here on the coast. The concern was that the Republican Guards would either be committed against the Marines very quickly or would move across the Euphrates River before VII Corps got up there to take them out. So we moved a day early. There was an acceleration of the Corps' tempo to accommodate early success by the Marines. So we attacked on G-day around the western flank of the enemy defenses, conducting offensive cover. Again, the key was to set the terms of battle, set the stage for the commitment of the armored divisions.

Next slide (Slide 4--Covering Force). A bit of Army doctrine. No Army presentation is complete without something out of a field manual. This comes out of Field Manual 17-95, which is the cavalry bible. Every good cavalryman has this in his vehicle somewhere. Published at Fort Knox, this manual told the Regiment what it was the corps commander intended for us to do. Let me try to interpret a little bit of this

COVERING FORCE
(FM 17-95)

- ✔ RECON CORPS AXIS
- ✔ DENY ENEMY INFORMATION ON MAIN BODY
- ✔ DEFEAT ENEMY SECURITY FORCES
- ✔ DEVELOP SITUATION; SET TERMS OF BATTLE
- ✔ ORIENT ON MAIN BODY
  - FACILITATE MANEUVER; PASS DIVISIONS INTO FIGHT
- ✔ FIX ENEMY FORCES AS ORDERED
- ✔ EXPLOIT OPPORTUNITIES UNTIL MAIN BODY
  COMMITTED

We were supposed to recon the corps axis--we were not only looking for the Iraqis, we were looking for prominent or impassable terrain. The early reports on terrain were going to be as important as the enemy reports, because we had not been up there before--this was Iraq. We wanted to deny the enemy information on our main body, which were the two armored divisions. We did not want Saddam to know where those two armored divisions were, so we were going to take out Saddam's eyes and ears, his scouts on the ground, and deny them the information of General Franks' forces. Defeat his security forces, develop the situation, we talked about that. Orient on the main body, the corps main body, or those two armored divisions behind us. Pass the divisions into fight at time and place of General Franks' choosing. Fix the enemy forces. That very simply means prohibit their movement, fix them in place. And then, if possible, exploit opportunities that might present themselves before the main body arrives.

It takes a long time to move a 20,000-person armored division with something like 3,000 or 4,000 vehicles. Cavalrymen like to point out the big difference between a cavalry regiment and an armored division. Size and agility are two principal differences. The reason the corps commander wanted a cavalry regiment out front was that it was very agile, and it was answering only to him. Our chain of command ran directly to General Franks, so he had a very unified picture across the corps axis of what was going on.

Next slide (Slide 5--Terrain). Many have said that this was flat, table-top desert. That is not exactly right. There was some discernible terrain out there. Importantly, we found some soft sand about 20 kilometers across the LD (the line of departure), which was the border berm. Our support squadron, which is dominated by heavy trucks made even heavier now by fuel and ammunition loads, had some problems there. There were gentle rolling slopes, actually the watershed leading down to the Euphrates River valley. The Euphrates is way over here off the map. But from here, just across the border, there are very gentle rolling slopes all the way down to the Euphrates. So it was a watershed, an indiscernible sloping down gradually as we moved. Only over 50 to 100 kilometers could you really make much of it.

TERRAIN

✔ CHARACTERISTICS
- SOFT SAND, WATERSHED 20KM BEYOND LD
- GENTLE ROLLING SLOPES ELSEWHERE
- FEW ROADS

✔ EFFECTS
- UNCONSTRAINED MOBILITY, EXC. FOR HVY TRUCKS
- LONG RANGE OBSERVATION, FIELDS OF FIRE
- REVERSE SLOPE DEFENSE POSSIBLE
- AIR SUPERIORITY VITAL

✔ WEATHER
- 50% NO FLY
- STANDOFF ADVANTAGE OF THERMAL SIGHTS

There were very few roads and that is important. Again, the use of the GPS, the little hand-held navigation device, was crucial, because we had nothing else to key our maneuver to.

What were the effects of that terrain? First of all, we had largely unconstrained mobility, except for those trucks I mentioned. The second one is the most important--long range observation and fields of fire. The Regiment was alerted just after the first week in November when the second announcement was made augmenting the in-theater forces in preparation for offensive operations. When the Regiment came out in that list they were surprised--most of them found out when they were watching the nightly news that night in Germany. At that time, the Regiment had spent the last 45 years looking at Czech and East German border guards along the Iron Curtain. (Of course, it wasn't the Iron Curtain any more, so things were moving pretty quickly for the Regiment.) We found the terrain in the desert to be vastly different. To get a 3,000 meter shot in Germany is almost unheard of, and here you could shoot for 8,000 meters, if you could only acquire the target. So we had to quickly adjust our training standards and our expectations of what we could do in the close fight, as a result of there being no intervening terrain.

There was some possibility for reverse slope defense (on the back side of a slope). We found some evidence of that in this fight. it's not clear to me whether the Tawakalna actually intended to do that or whether they were just stupid. It gets into some technical details, but essentially they were too close to the top of the hill to make a reverse slope defense viable. But they may have been trying to employ a reverse slope defense tactic.

Finally, the desert makes air superiority absolutely important.

Weather has been mentioned before. Fifty percent of it was no-fly weather. I mean that 50 percent of a 24-hour day when you would expect to be able to fly we were unable to fly. As you'll see in a minute, being able to fly was to have been an important element of the Regimental concept. It proved not to be crucial because we didn't have the weather. We did have Apaches (AH-64), so we had what was supposed to be an all-weather aircraft. It got up as much as it could but some of the weather conditions were just too bad.

Finally, we had the technological advantage of having thermal sights--sights that picked up their images as a result of the heat from the target itself. Those proved critical because we could see through the intervening weather conditions. We could see through haze, fog, blowing sand and so forth. It gave us a huge advantage. The Iraqis had nothing to compare. So we had thermals, they didn't.

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(Slide 6--Enemy Forces.) We really faced a broad spectrum of enemy forces that ranged from very poor to the best they had. I'll leave you to decide how relatively good the best they had proved to be. The 26th Infantry Division is on the low end of the spectrum. They were the poor guys who were the corner division, on the western end of the defensive line. They had two brigades here on the corner and one brigade here about 40 kilometers north. It appeared they were arrayed to deny that right flank. The bad news is they got a new commanding officer on 15 January. If you put that in perspective, I think that the air campaign started on the 17th. So this fellow probably didn't get around to see his division. We probably saw more of the 26th Infantry Division than that commander did. They were all conscripts. These guys essentially wanted to surrender; they wanted someone to drive up and take their surrender.

ENEMY
VARYING CAPABILITIES

✔ **26 INF DIV**
- 34 T-55 TANKS
- CONSCRIPTS
- NEW C.O. -- 15 JAN
- LOW MORALE

✔ **12 ARM DIV, JIHAD CORPS**
- T-55, T-62
- REGULAR ARMY
- C-PEN MISSION
- GHQ CONTROL

✔ **TAWAKALNA DIV**
- T-72, BMP, WELL SUPPLIED
- ELITE (?)
- IN DEFENSIVE POSITIONS

On the next level I'd rate the regular army 12th Armored Division. They started out in what they called the Jihad Corps where the 12th and the 10th Armored Divisions were located about here (just east of the Tawakalna). Early on in the ground ca paign a brigade from the 12th Armored Division was sent by happenstance to the middle the VII (US) Corps axis. This only became apparent after interrogating the brigade commander. He told us how his division commander called him and said, "Remember that spot we reconned several months ago? I want you to go there. There's some crazy report about 8 French tanks that have skirted around the right flank. Take your brigade and destroy these tanks and hold down the right flank for us." We captured this brigade commander after he had made an -night road march. As it turns out he was quite disturbed that there were not French tanks and there were far more than eight. So he felt a bit betrayed perhaps by his chain of command.

The 12th Armored Division was more capable. They had T-55's (a 40-year-old tank) and T-62's (a 30-year-old tank) with no thermal sights. These tanks are dangerous, but not first rate. This division was regular army. They had a counter-penetration mission, as I just described. They were sent to counter a penetration on the right flank. They w re under General Headquarters control which is interesting in terms of how control in the Iraqi army appears to have been held at very high, very centralized level.

The cream of the crop that the Regiment faced is one of the Republican Guards divisions. The battle of the 73 Easting was against the 18th Brigade, one of the three brigades of the Tawakalna Division. The 18th was the southern brigade of three brigades from north to south. So, when we talk about the 73 Easting battle, it was the 18th Brigade of the Tawakalna that we actually hit. They were the best supplied of the Iraqi Army, with T-72 tanks, the front-line export version of modern Soviet tank technology. They were elite by Iraqi standards. They were in standard Iraqi defensive positions, not good enough by our National Training Center standards. They did not really appreciate what a defensive position requires today against our ammunition and target acquisitions systems.

(Slide 7--Task Organization) This is what the Regiment went to combat with. The Regiment organically has about 4500 soldiers. We crossed the berm with just over 8000. There are three organic ground cavalry squadrons, each with 41 tanks and 38 Bradleys. Our 4th Squadron is the "Dragoon Air Force," with about 75 helicopters, including 26 Cobra attack helicopters. Regimental Support Squadron is the logistics support.

TASK ORGANIZATION

1/2 ACR	REGT SPT SQDN
84 ENG CO	71 LTF
2/2 ACR	214 MP CO
6-41 FA BN	REGT CONTROL
A/82 ENG BN	87 CHEM CO
3/2 ACR	502 MI CO
3-17 FA BN	B/511 MI BN
C/82 ENG BN	2-1 AVN BN
4/2 ACR	82 ENG BN
FORCE ARTILLERY	172 CHEM CO
210 FA BDE	
C/4-27 FA BN (MLRS)	

The most important combat multipliers were three. First, we had a brigade of field artillery. Most important in this brigade were 9 MLRS launchers which in effect gave us another battalion cf fire power. Second, 2-1 Aviation Battalion, from 1st Armored Division, brought us 18 AH-64 Apache helicopters. They gave us an all-weather, and especially a night-time, tank-killing capability deep, forward of our front lines. Third, the 71st Logistics Task Force from VII Corps provided the support we required to move far and fast, independently.

(Slide 8--Combat Assets) What does this all total up to? We crossed the line of departure with 123 tanks. OH-58C/D's are scout helicopters. AH-64's are the Apaches. We had 72 howitzers and nine MLRS supporting the Regiment. That is about the combat power of one-half a division.

(Slide 9--Concept of Operation) This is the concept of operation, probably the most important paragraph in any Army operations order. G-6--6 days before the ground attack

COMBAT ASSETS

MIAI TANKS	123
M2A2/M3A2	116
AH-1	26
OH-58 C/D	34/5
AH -64	18
155MM HOW	72
MLRS	9

CONCEPT OF OPERATION

✔ G-6 DEFENSIVE COVER
- "QUIET"; RECON LD; 2 SQDNS ABREAST

✔ G-1 ATTACK TO SECURE LD
- ARTY PREP, C-RECON, REDUCE BERM

✔ G+1 OFFENSIVE COVER FWD OF 1AD, 3AD
- ENVELOP ENEMY FORWARD DEFENSE
- AVN 20KM AHEAD, 2 SQDNS ABREAST

✔ "CARRIER WARFARE"
- LONG RANGE DETECTION; EARLY ATTACK
- THEN, HASTY ATTACK OR DEFENSE

✔ IF ENEMY MOVING, DESTROY ADV GUARD , FIX

✔ IF ENEMY STATIONARY, FIX, FIND FLANKS, PASS DIVS

was to have begun--we began the defensive cover which was the operation south of the border berm. We went up there quietly; the intent was not to give away the plan to go around the flank. We reconned the line of departure with long-range surveillance units and we formed up with two squadrons abreast: 2nd Squadron in the west and 3rd Squadron in the east. That arrangement was fateful, because those are the same two squadrons that after we turned the corner around the Iraqi defenses end up in the battle of the 73 Easting. So the stage was set when we lined up in Saudi Arabia probably 10 days before the battle.

A day before the ground attack was to begin (on G-1), we took the border berm. We conducted a short, sharp combat action to move about 20-30 kilometers across the berm into Iraq. There were two reasons for that. First, we wanted to take away his scouts--his eyes and ears--positioned on the border itself. We didn't want some lone Iaqi scout earning a huge medal after the war because he made the key spot report that General Franks was coming around the right flank. We wanted to take out his reconnaissance along the berm. Second, the berm had to be reduced. I think you saw a picture of it in General Funk's presentation. It was about 10 feet high and there were two of them. This made a considerable obstacle for a tracked vehicle, certainly enough to slow you down. We had to get across the berm to allow our combat engineers time to get up and reduce the obstacle. They needed to cut lanes in it. That is why we went across the border one day early.

The plan called for us to begin our offensive cover in front of the two armored divisions on the day after the Marines kicked off their attack into Kuwait (that is, on G+1). The idea was to envelop the Iraqi defenses. The basic concept was that we were going to fly our 4th Squadron helicopters 20 kilometers out in front of our two ground squadrons abreast. An analogy can be made to the Battle of Midway where the idea was to launch the aircraft off the aircraft carriers, send them out for long range detection of the enemy and then maneuver the rest of the fleet in for the kill. That is very close to what we tried to do for VII Corps. We wanted to launch our helicopters, detect the enemy early, then cause attrition with long-range systems--MLRS, Apaches, Cobra helicopters--before the ground squadrons came in contact.

The 20-kilometer interval and the time gained by engaging the enemy early gave us room to maneuver the ground squadrons. That 20 kilometers belonged to Colonel Holder; that was his time and space to make tactical choices. So the idea was to learn about the enemy early, and have a little reaction time. As it turns out, the poor weather conditions

(50 percent no-fly weather), which we had not anticipated, caused us to have to depart a bit from this concept. Our helicopters didn't fly all the time.

Once we touched the enemy, we wanted to conduct either a hasty attack or a hasty defense depending on what we hit. If the enemy were moving, we wanted to take out his advance guard, which was his counterpart to us, and then we wanted to fix his main body. It turns out he wasn't moving, so this did not apply. Since the enemy was stationary, our job was to fix him, to identify a flank, and then pass the divisions behind us into opportune spots. As you'll see, that is pretty much what happened.

(Slide 10--Operation Summary) The 26th of February is the day of the Battle of the 73 Easting. On the 26th we passed 3rd Armored Division around us to the north and eventually passed 1st Infantry Division through the Regiment oriented east. It was during the process of coordinating the passage of 1st Infantry Division that the Battle of the 73 Easting took place. It was late afternoon, early evening of the 26th of February. After that, the Regiment became Corps reserve. About 18 hours later the war ended with the cease-fire.

OPERATION SUMMARY

23 FEB -- SECURE CORPS' LD
24 FEB -- COVER FWD OF 1AD AND 3AD
25 FEB -- PASS 1 AD, COVER 3AD
✔ **26 FEB -- PASS 3AD, COVER/PASS 1ID**
27 FEB -- CORPS RESERVE

I will focus now on the Battle of the 73 Easting. (Refer to Slide 1--Regimental Graphics) Late on the 25th we had moved up our axis and secured our Objectives Gates and May. Early in the morning on the 26th we received a frag order from Corps. The essence of this order was that the Regiment was to turn east to find the Republican Guards while the rest of the Corps came on line facing east. So that's what we did. These dotted graphics were drawn after the plan was issued. These are the subsequent graphics that brought the Regiment into contact with the Republican Guards. You can see what we did: we moved from Gates and May, oriented east and moved out.

Early morning on the 26th, we moved with three squadrons abreast: 2nd Squadron in the north, 3rd in the center, and 1st in the south. We did that because our axis was broader and also because we expected heavy contact. We expected to touch the Republican Guards for the first time.

When we moved east we had not received any specific information on where we would find the Tawakalna. I think that we could do better with the dissemination of intelligence in the theater. The Corps had not seen them with the human eyeball yet. Our task was to find them.

The first spot report that the Corps received on the Republican Guards was the Regiment siting a T-72 tank. The report came from a combat aviator in 4th Squadron and it was made on about the 60 Easting. The T-72 was in a platoon-size outpost which suggested to us that he was part of a security zone or the reconnaissance force in front of a stationary defense. It was quickly destroyed. The spot report that flashed immediately from Colonel Holder to General Franks was that the Regiment had touched the Republican Guards. We knew that because only the Republican Guards had T-72's. We made initial contact with the Tawakalna Division along the 60 Easting, then proceeded on to the east.

The Battle of the 73 Easting involved the northern three cavalry troops of the Regiment's eight troops abreast. G, E and I Troops fought this battle. Many are referring to them as Ghost, Eagle and Iron because these are their call-signs, what they call one another on the radio. These three troops essentially destroyed the 18th Brigade of the Tawakalna Division. The heart of the fighting took about 90 minutes. The three attacking troops were outnumbered three to one. American doctrine calls for the attacker to outnumber the defender by at least three to one. If you consider these inverted ratios, it was a stiff fight.

I believe our success was a combination of many factors including great technology. We're going to see a lot of technology here today. Our challenge as we walk out of here after three days is to remember that the most important factor, however, is the man behind the technology. The soldiers in the tank turrets and the cockpits of those helicopters are the ones who made the decisive difference.

(Slide 11--Battle Results) The bottom line is we made contact with the Republican Guards, reported it and the Corps commander then committed his reserve, the 1st Infantry Division. This is where the tactical level merges with the operational, because the 1st Infantry Division then proceeded to cut right through what was left of the Tawakalna and ended up just north of Kuwait City astride the Iraqi evacuation routes.

BATTLE RESULTS

✔ **2ACR MISSION ACCOMPLISHED**
- COVERED 3 DIVISIONS, MOVED 120 MILES IN 82 HRS, FOUGHT ELEMENTS OF 5 ENEMY DIVISIONS
- INTEGRATED CAS WITH GROUND OPS CONTINUOUSLY IN GOOD WEATHER
- DESTROYED ENEMY SECURITY FORCES
- FIXED, DISABLED TAWAKALNA DIVISION
- DEVELOPED SITUATION FOR THE CORPS COMMANDER

✔ **CONDITIONS -- 50% OF BATTLE FOUGHT IN LIMITED VISIBILTY, NO-FLY WEATHER**

✔ **BATTLE EFFECTS**
- ENEMY -- DESTROYED OVER 300 AFV'S, CAPTURED 2000+ EPW'S
- 2ACR -- 6 KIA, 17 WIA, 4 M2 AND 2 M113 DESTROYED
- 95% O.R. THROUGHOUT BATTLE

The results speak for themselves. AFV stands for armored fighting vehicles and about 120-150 of the 300 that the Regiment destroyed were destroyed in the Battle of the 73 Easting. This includes about 80 T-72's which is about 2 Iraqi battalions. We captured about 2000 EPWs (enemy prisoners of war), with very few from the Tawakalna Division. O.R. is operational readiness and shows the degree to which our combat vehicles were prepared for combat.

Let me end there and take a few questions.

Q: What configuration were the troops in?

A: (LUTE) Each squadron's perspective was a little different. Up in 2nd Squadron you had Ghost, and Eagle; behind them were Fox Troop and Hawk Company, which is the tank company. So they were in sort of a two-by-two arrangement. Third Squadron was three troops abreast and the tank company in reserve and 1st Squadron mirrored that. So we had two troops forward in the north, three troops abreast in the center, and three in the south for a total of eight.

Q: The Tawakalna Division was well supplied, what kind of rations and ammo did you find?

A: (LUTE) Full stocks of ammo, much of it in bunkers beyond the basic load that the vehicle itself carried. There were plentiful stocks within several kilometers with several trucks available to haul that. The troop bunkers which were positioned adjacent to the T-72 tanks were I'm sure built as a result of the air campaign. They had decided that it was not safe to reside in one's tank during the air campaign. These bunkers revealed fresh fruits and vegetables, plentiful stocks of potatoes, fresh water and so forth. So they were doing all right.

Q: Touchy area, but were you assisted by special ops in your operation?

A: (LUTE) Too touchy. Not substantially so. They were looking for other things at that time. They did not contribute to this battle.

Q: Was this battle, being an armored cavalry regiment battle, sort of because you were under limited visibility if you had seen them earlier you would have passed to the division and let them do the fighting, or would you have gone...

A: (LUTE) That would have been a different decision. If you change the parameters that dramatically, General Franks would have faced a different decision which was whether he would still have wanted us to grab and fix the enemy, or knowing what was there, would he have committed the 1st Infantry Division earlier. And I'm not sure how that would have panned out. As it was, the weather prohibited us from really knowing what we faced until the battle was in progress. It is hard to say. It's a good "what if."

Q: It's possible given that if you had known earlier, you still probably would have...

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A: (LUTE) It is possible because we do have that clause in our concept that calls for us to fix the enemy. We literally fixed him. He's still there in the desert, by the way.

Q: RPVs?

A: (LUTE) The regiment had no remotely piloted vehicles available to it. The Corps did and the Corps used them especially prior to the kickoff of the campaign. But once the campaign started, it moved so quickly that keeping the RPVs up and targeted against useful things proved very difficult. So during this portion of the campaign, RPVs did not play a role. And, the weather conditions would have prohibited any useful intelligence being gathered from RPVs in this particular fight. But they were used before we crossed the border.

Q: Any new information from JSTARS or anything else?

A: (LUTE) I won't go into any details, but yes. We got a couple of key reads from JSTARS and a couple of key reads from SLAR, which is side looking airborne radar. Those were important reads. They told us about things that were happening beyond the Regiment's view, in depth. Yes, they were useful.

Q: Did they get out of their defensive positions, once you touched them or were most of them killed?

A: (LUTE) It's a mixed story. Initially the reports seemed to suggest that they thought they were under air attack because they couldn't imagine that anyone was going to come at them in those weather conditions on the ground. Because they could not see anything, they didn't appreciate that we could. So initially they were very much in their bunkers. Once they saw us, there was a flurry to mount their combat vehicles, so it's a question of where you caught them in that game.

Q: What model BMPs were used?

A: (LUTE) BMP-1's.

Q: How useful were OH-58D's?

A: (LUTE) They were all-stars. The OH-58D's give the typical scout helicopter a thermal target acquisition capability and a laser designator capability. They were exceptional, very useful. We had five, only one platoon, assigned to us. We would have gladly traded in every scout helicopter we had for more. They were fantastic, very useful.

Q: About what percent of the vehicles that showed hot in your thermals as opposed to cold were dead or were not turned on?

A: (LUTE) Virtually all of them showed hot. Whether they were burning or not. I think it's just the temperature differential from the object compared to the air around it. If any of us park our car and leave it for awhile it will still show hot relative to the air around it. It's the principal of the mass of the material itself. It will absorb heat and dissipate it not as quickly as the air around it. So they all showed hot and we shot.

--73 EASTING--

PRESENTATION OF THE FIGHT (TROOPS)

Colonel Gary Bloedorn, USA (Ret'd)

Institute for Defense Analyses

GARY BLOEDORN

Orientation Scale of the Maps-- Sequence of Events. What I'll do is tell you what I'm going to tell you and then use the technology to tell you what happened in the battle, then we'll come back and summarize. I'll show you pictures of the battlefield that we simulated, and then answer your questions. Fair enough? All right, let's have the first slide please.

ODIN SNAPSHOT SLIDE 1: G AT 1530

Scale 1/25,000 each square is 1 km per side. This depicts, as Major Lute stated, that at 1530 on the 26th, the northern flank of the 2nd Cavalry Regiment (at this time the northern flank of the VII Corps) was right here. Capt. Joe Sartiano, commander of Ghost Troop, was mounted in his main battle tank right here. He had echeloned his scout platoon. These are Bradley fighting vehicle symbols. He had echeloned his flank. By so doing he had denied that flank, protected the flank of the Regiment, and protected the flank of his troop. His tank platoons, second platoon here, fourth platoon here, totalled eight M1 tanks, were in a vee formation and he was at the lead making a total of nine tanks. The concept being, that with his scouts out, he could find the enemy, and be prepared to commit his tanks as needed. Tucked up very, very tight were his two 4.2 inch mortars, his troop tactical operations center, medics, maintenance and his first sergeant. As we visit Joe here, it is 1530 hours, a dark and gloomy day with about 600 meters visibility, lots of blowing sand, and at this time a wind with about 60 knots velocity from due south. Please keep these weather conditions in mind as you watch the battle develop. Keep in mind also that the M1 Tank is equipped with a wind sensor that automatically measures the velocity and the direction of the wind. It also has with it a powder temperature sensor, so these variations in wind and temperature occur, the M1's fire control system was automatically compensating for conditions.

I-122
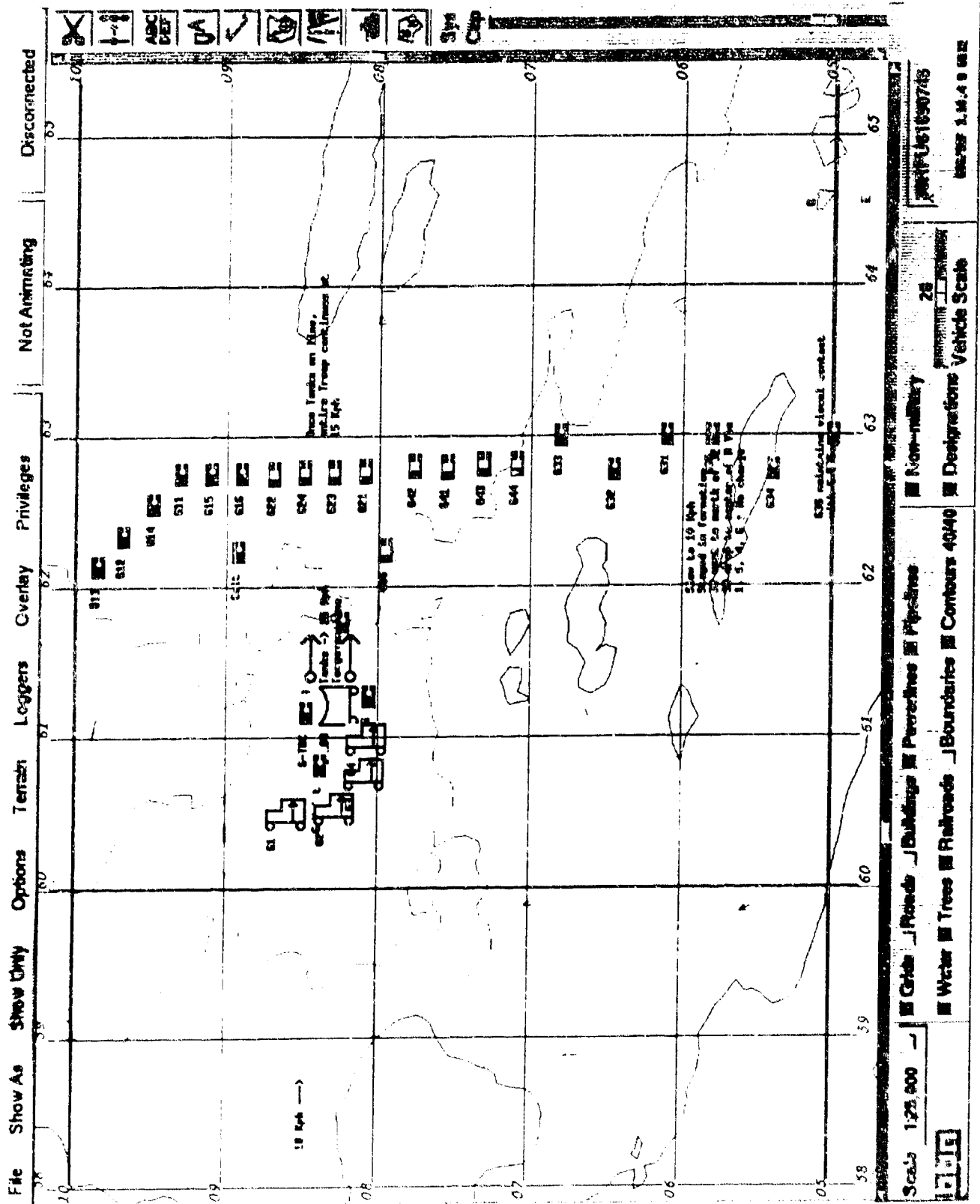
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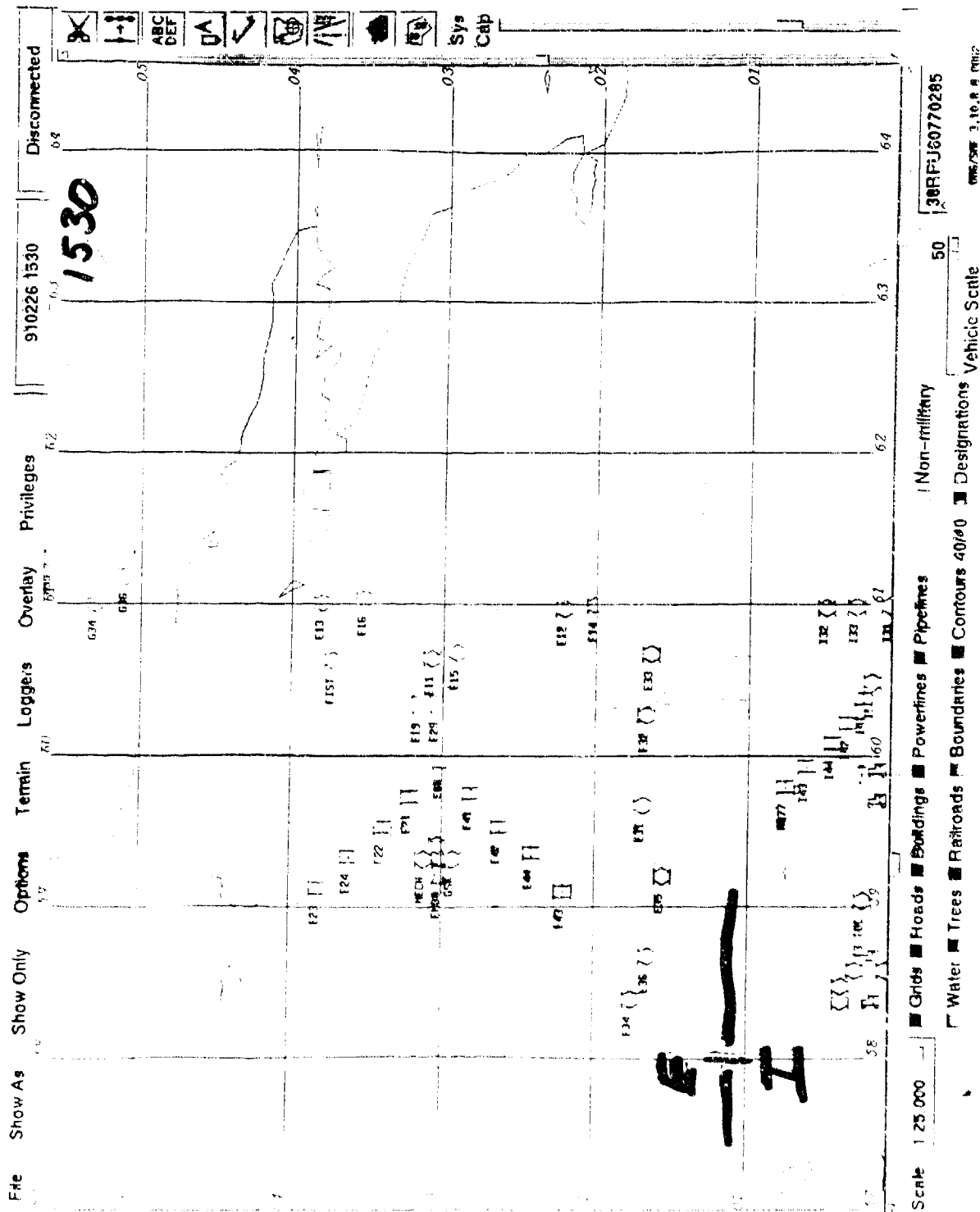ODIN SNAPSHOT SLIDE 2: E & I AT 1530

Just south of the Ghost troop is Echo troop or as the 2d ACR calls it Eagle Troop. Also in his main battle tank is Captain HR McMaster, the troop commander. In keeping with Captain McMaster's personality, which Major Lute has told you is kind of aggressive, sort of feisty, he's put his mortars out front. He wants to hit them as fast as he can and his mortars almost in lead the attack. The scouts are deployed across the front as you see them. CPT McMaster is up forward, he's got his first scout platoon spread across 5 km and, importantly, he has spread his 3rd scout platoon out on the southern flank of the troop to maintain contact with the 3rd squadron down here--because a gap could develop and because it's so important to know where that squadron is to avoid fratracide. He's devoted an entire scout platoon to make sure that nothing can get in between the 2d and 3d Squadrons. That sets the stage. In the south we'll go visit Iron Troop and the 3rd squadron--but one other thing that is on this chart. At this time the squadron commander is with Eagle and the S3 is up with Joe Sartiano. It's important to understand that throughout the fight the commissioned leadership, field grade officers on down, were very far forward. As you see the fight develop, you'll see the officers are with the lead elements. They lead their troops in the truest sense of the word.

Next slide.

ODIN SNAPSHOT SLIDE 3: I AT 1530

Here's Iron, part of the 3rd Squadron, and we see yet again, another variation in formation. Captain Miller has placed his scouts across his front. Security forward. His tanks are in the ubiquitous vee. Here's the Squadron Sergeant Major, he's got a battle tank out of headquarters and he's up with the lead tank platoon. The Sergeant major is gonna get in the fight.

To summarize the troop deployments, the Tactical Operations Centers and trains are back here, the mortars and their ammo carriers are up close. Mortars are always up forward throughout the fight.

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1530

Scale 1:25,000

☑ Grids ☑ Roads ☑ Buildings ☑ Powerlines ☑ Pipelines | Non-military
☐ Water ☑ Trees ☑ Railroads ☑ Boundaries ☑ Contours 40/40 ☑ Designations   Vehicle Scale

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Sys Cap

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I-125
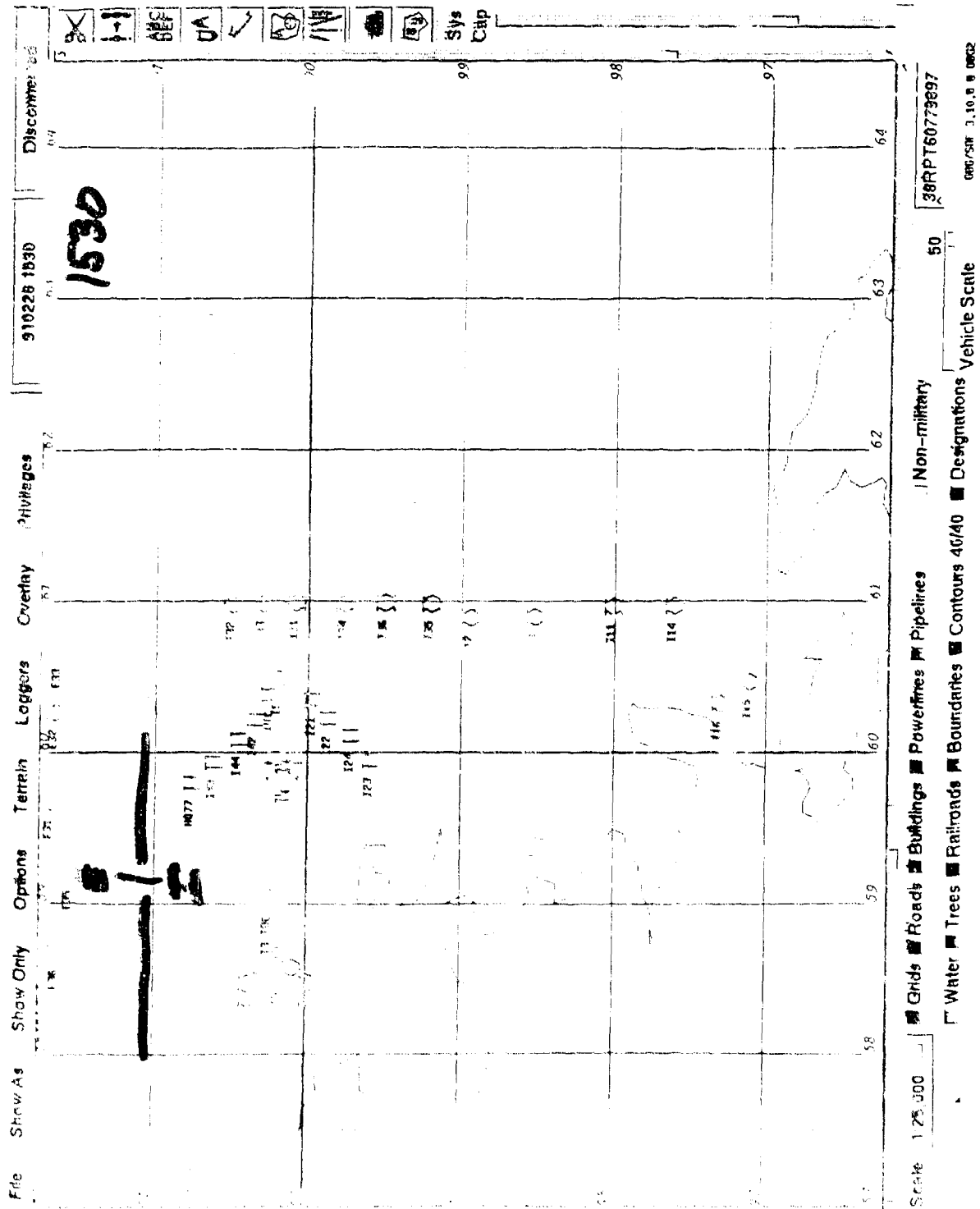
In this battle, we have a unique situation. It is not like anything seen before. In the past, we have been conditioned to the violence of combat, the mass of forces with artillery and air coming in, armed helicopters, lots of tracers, nothing like that here. You are looking at a 15-km front with three Cavalry troops moving abreast to gain contact. Remember General Funk stated that the entire 3rd Armored Division, 20,000 men, was on an 18-km zone. I have just shown you 15 km with 3 cavalry troops and it is on this frontage that three troops of cavalry will go into close combat with a brigade of the Tawakalna Division and elements of the 12th and 52d Armored Divisions.

Next slide.

ODIN SNAPSHOT SLIDE 3A: G AT 1605

We're going to show you, sequentially now, the battle as it happened. The three troops, along with the entire regiment, moved forward in their formations. You see Ghost here, and around the 69 Easting you will see they find the Iraqi reconnaissance elements, run into a mine field, and they take appropriate action.

Next slide.

ODIN SNAPSHOT SLIDE 3B: G AT 1617

Ghost dispatches the Iraqi security elements and continues on its mission. By 1700 hours, 90 minutes after jumping off, they are approaching the 73 Easting. They do not know at this time that out in this location is a mechanized infantry battalion, in a defensive position, directly along their line of advance. You'll see in the simulation what happens when they encounter that battalion.

Next slide.

ODIN SNAPSHOT SLIDE 4: E AT 1605

In the meantime, Echo is still moving at 1605, we're still at a scale of 1/25,000. Echo is slightly behind Ghost at this time moving forward, scouts out, the troop formation is about the same. At the this time Iron troop discovers reconnaissance elements on the flank of Echo. You'll see the engagement, how quickly they eliminate that and the entire force continues its movement forward.

Next slide.

ODIN SNAPSHOT SLIDE 4A: I AT 1605

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Scale   1:50,000

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Water   Trees   Railroads   Boundaries   Contours 40/40   Designations   Vehicle Scale

40

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Scale 1:25,000

Grids Roads Buildings Powerlines Pipelines Non-military
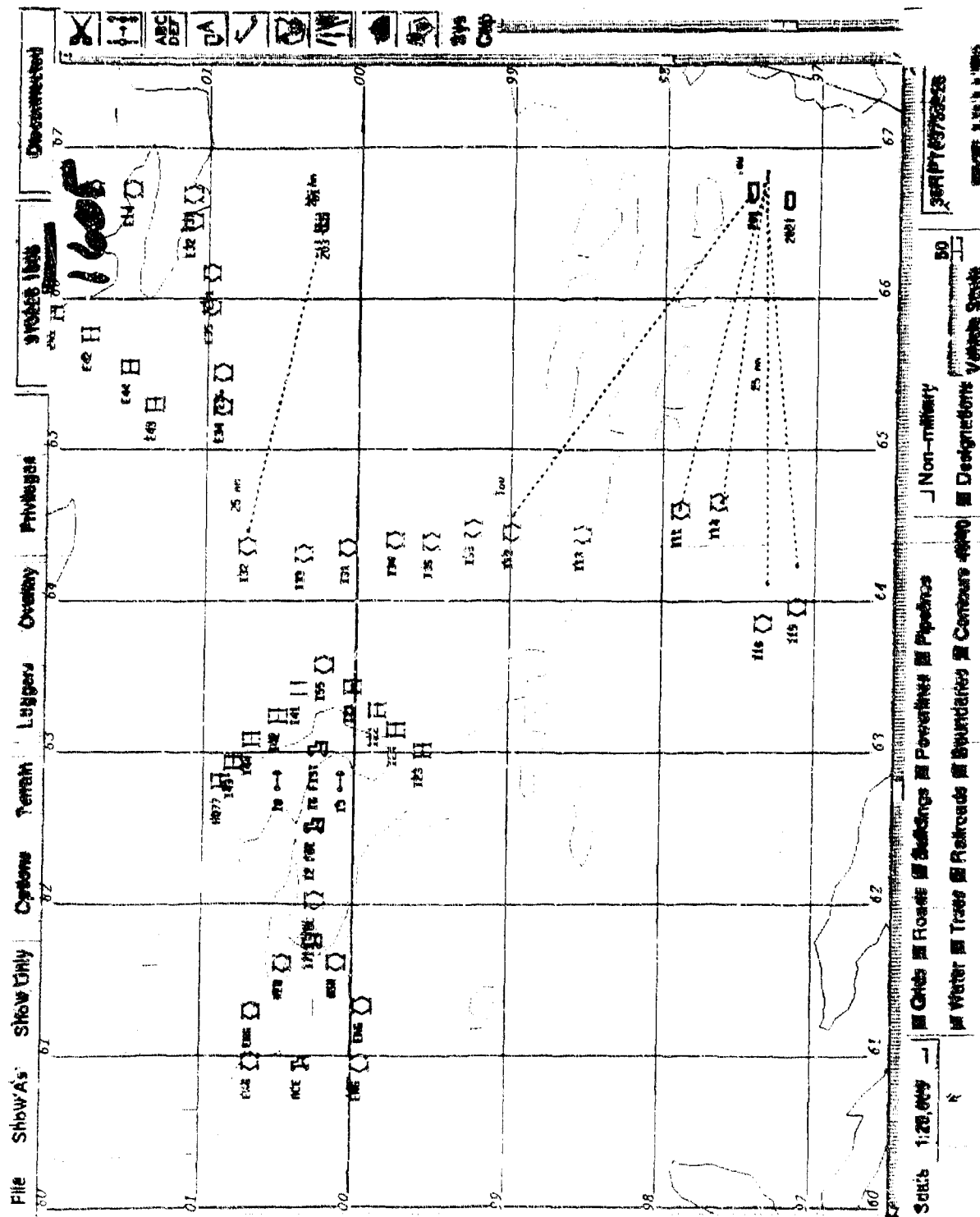Water Trees RailCards Boundaries Contours 40/M BldgPatterns Vehicle Scale

I-129

I-130

Here you see Iron coming in at 1605. The first battle started here, then down in this location, almost simultaneously they found more elements and look at the long tow range here. The troops receive fire with 600 meters of visibility and are shooting at something over 2,000 meters range. You'll see 25mm fires going out 1800 meters and you'll see all of those engagements. Important for you to understand, and I'll show you the statistics of the battle, but the probability of hit was somewhere around 0.95 and the probability of kill here was almost binary. General Funk showed you that today, when he showed you his main battle tanks fired 774 rounds (120mm). That's the entire campaign and that's less than 3 rounds per tank. You'll see similiar gunnery expertise in this battle and that's what makes it unique, the reason that I mention it. We do not see the mass of fire power as in past battles. We can now talk in terms of precision of engagements as opposed to simple fire power. They didn't have to fire very many rounds in order to do this job and that's what the simulation shows very clearly as we reenact the battle.
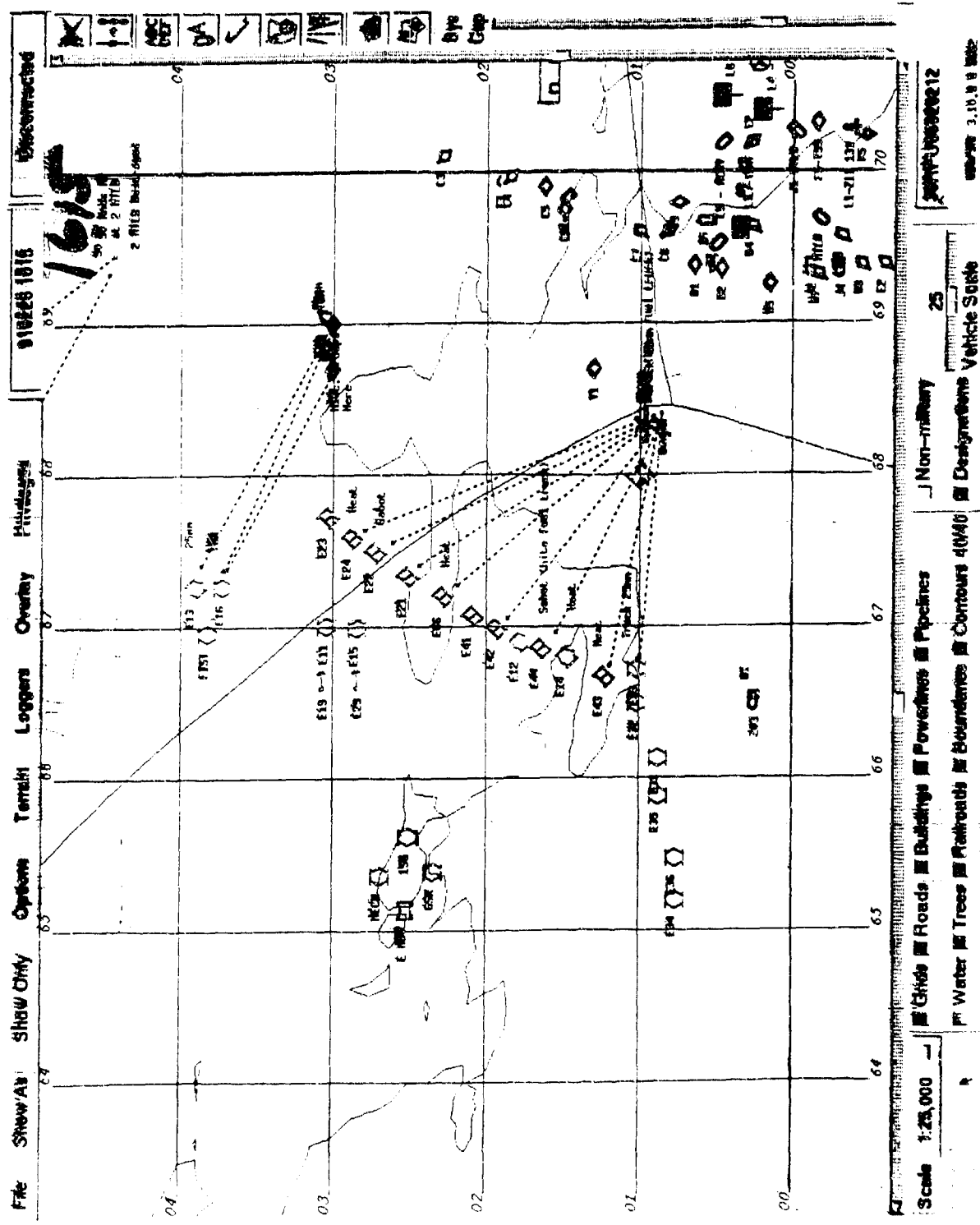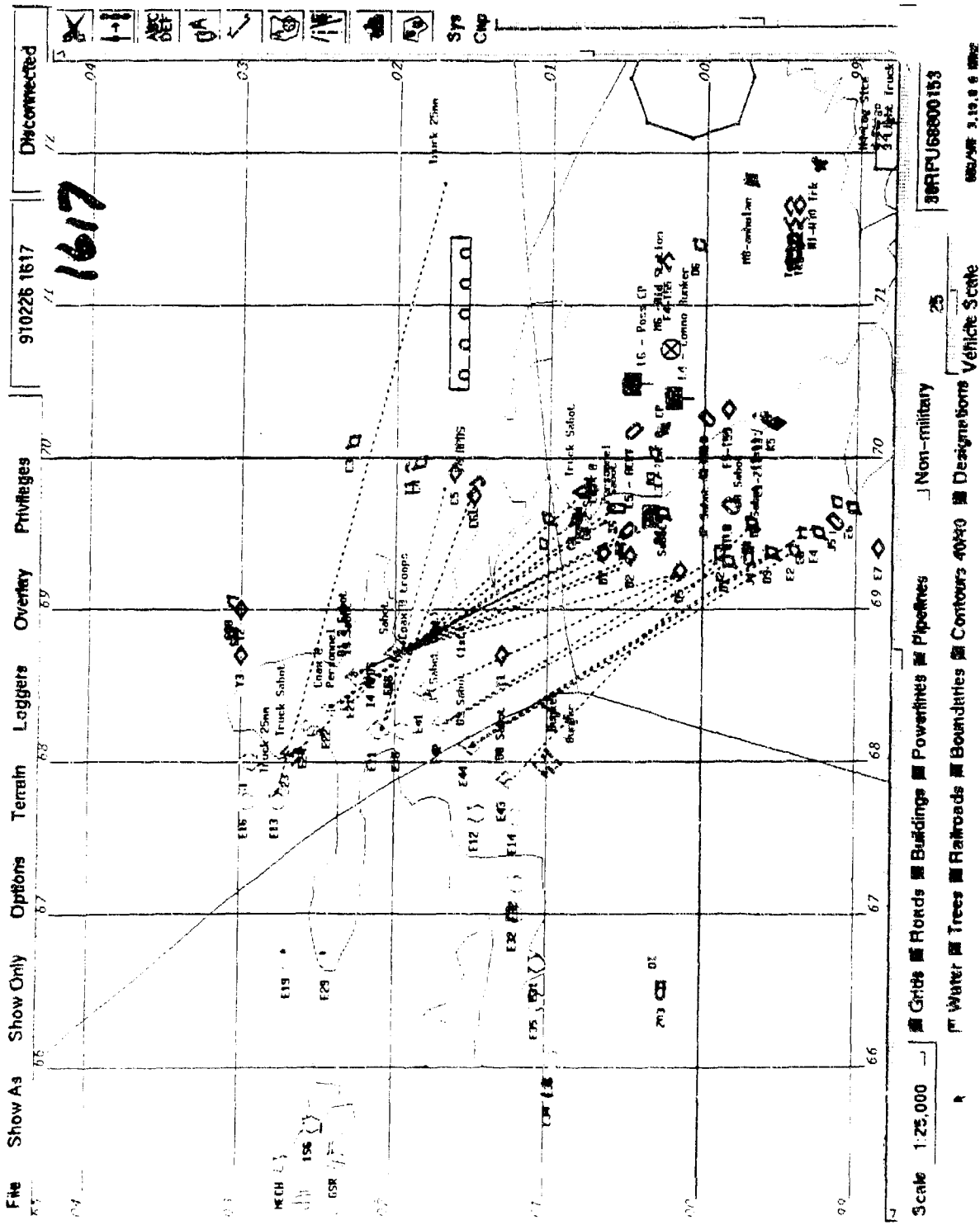
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ODIN SNAPSHOT SLIDE 4B: E AT 1615

The big battle starts as Echo approaches what is being called the village (you have seen pictures of it outside). The Republican Guard security elements took Echo under fire and that triggered a series of events. I show you this slide, you will see it as we have reenacted the battle. But again, the data in these slides were not prepared for this briefing. These slides depict the way we communicate the battle data to the software engineers. You are seeing now the precise means of communications where we show where vehicles are, and I have just taken a sample of many, many, many of these. We are showing you each round, support units, fuel trucks, ammunition trucks, and dismounted infantry.

Next slide.

ODIN SNAPSHOT SLIDE 5: E AT 1617

About the time they took the Iraqis under fire in the village Captain McMaster, in the lead tank, decides to move tanks forward. And when this young man says move forward, he means move forward. You will hear his very voice on the tape tonight as we run through the battle.

1617

Tank 25mm

Tank 25mm

16 - Poss CP
Comno Bunker

Truck 25mm

Truck Sabot
Sabot
Sabot
Foam Troops

Truck 25mm
Truck Sabot

MECH

GSR

Grids Roads Buildings Powerlines Pipelines
Water Trees Railroads Boundaries Contours 40X40 Designations   Non-military   Vehicle Scale

3BRFU68800153

The whole battle took 6 hours, so I've chosen a sample of things to show you. At this point you will hear his command voice and his command net. We'll be able to synchronize that in the finished product and you'll see the action on the screens and you'll hear the way he used his command tank to lead his forces forward and start this battle. This is the point that we will start the tape and you will hear the fight.

Next slide.

ODIN SNAPSHOT SLIDE 6: E AT 1625

By 1625, you're looking at Echo having gone through the first belt of the first defensive position of the battalion of the Tawakalna. Iron is coming up down here and Echo is through and moving at about 15 to 18 km per hour firing on the move with the tanks leading and the scouts behind covering all the troops of the tanks. The Iraqi infantry now was coming out of their bunkers trying to fight back, trying to rally themselves, and they were also closing in behind the tanks, where they surrendered. You'll hear this, if we're lucky, on the tape: "don't shoot, don't shoot, they've got their hands up." Major Lute also mentioned this. This devotion to the rules of land warfare was characteristic of the battle. When the Iraqi soldiers surrendered our soldiers cease fire, where the Iraqi soldiers chose to fight, they did what they had to do. That will be in the simulation. If you look carefully at this stage of development, you will see dismounted infantry, they are developmental icons marking the locations of infantry engagements. Further development will feature surrendering infantry, prone firing positions, RPG firing, automatic weapon firing, and all of the dismounted actions that took place on the battlefield, reflecting the data that we have.

Next slide.

ODIN SNAPSHOT SLIDE 7: E AT 1730

Eagle troop, having swept through the initial Iraqi defensive positions, starts to circle up and discovers the reserve of the 10th brigade of the Tawakalna, a T72 battalion in defensive position. You'll see the joint reduction of that position by Ghost and Eagle.

Next slide.

SLIDE 8: PHOTO OF IRAQI EPW MOUNTED ON BFV

This is Iraqi reactive armor. That's Colonel Thorpe's immediate reaction when I showed him the picture, I thought I'd share it with you. A man of rare humor. Iraqi reactive armor. Are there any questions before we start the battle?

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I-135

1730

Scale 1:25,000

Cities | Roads | Buildings | Powerlines | Pipelines | Non-military | Water | Trees | Railroads | Boundaries | Contours (400m) | Designations | Vehicle Scale
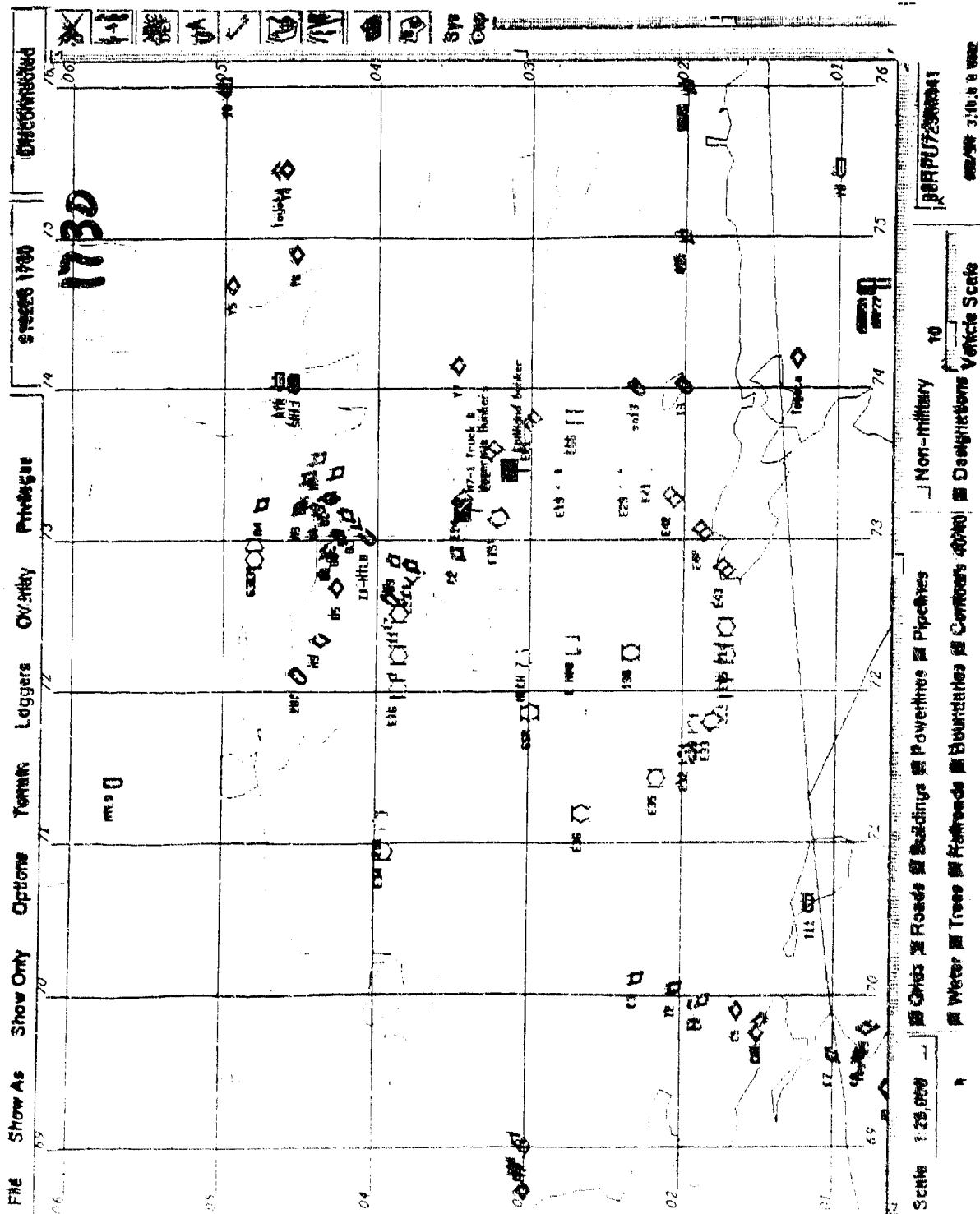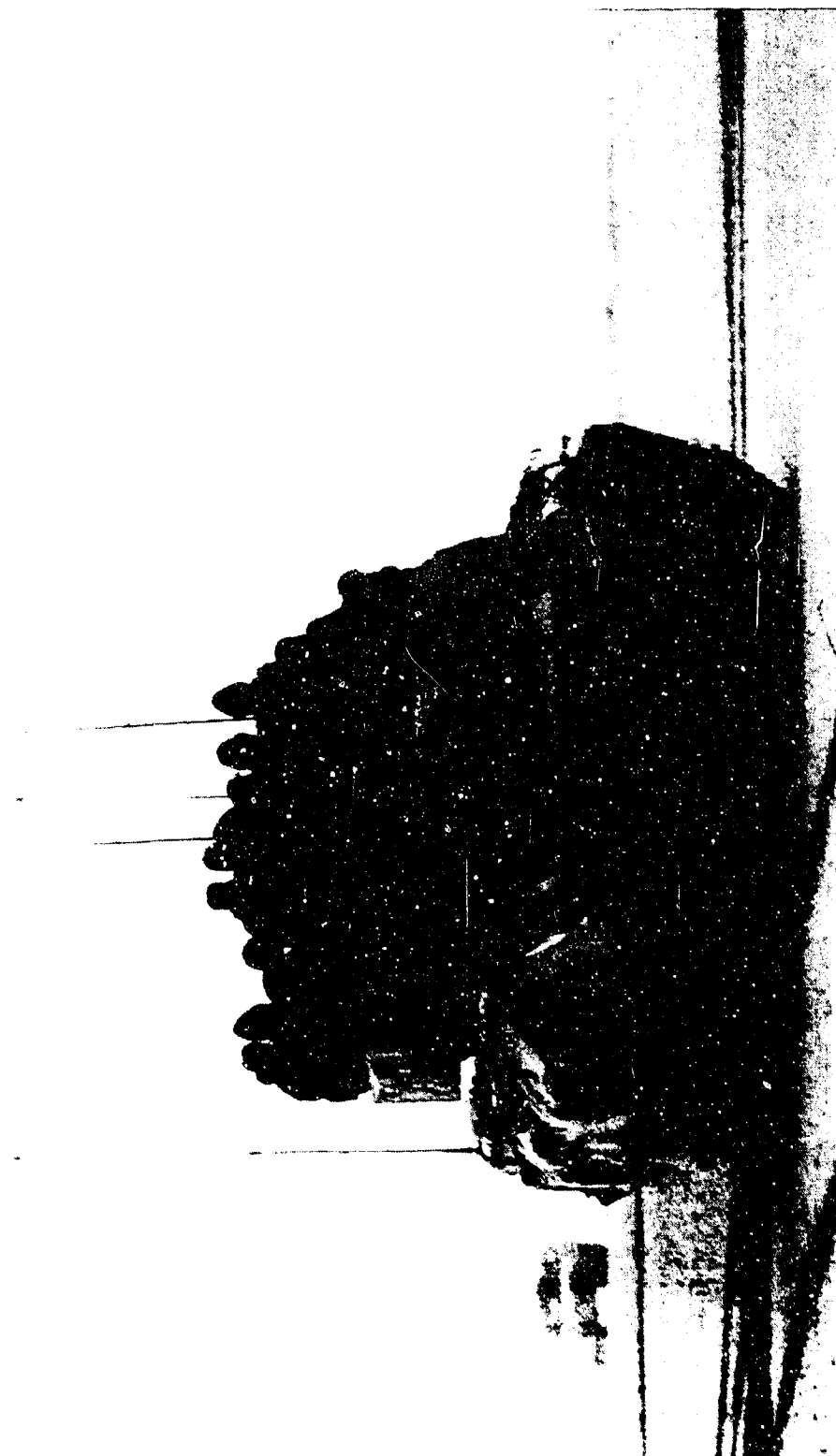
Eagle Troop 2/2 ACR transports EPW

Q: Was there much use of artillery or MLRS in this?

A: Yes. Thank you very much. Again, because in the battle itself it is a straight gun fight. It is across 15 km, cavalry spread out. Very limited use of any other arms. The finished simulation shows you when the mortars fire, the mortars were very responsive. We found first round hits with mortar fires on hip shoots, they pull into the position, drop it in the tube and hit a bunker. So when the artillery calls for fire we find that the mortars come back and say "shot" before the artillery can process the mission. The GPS enabled them to do this by providing a ten-digit accurate coordinate of their present location. These guys were quick. As an aside, you will also see them in full simulation, the mortar crews used their small arms fire to fight as they rode through and fired on the Iraqis. This was a completely mounted battle from our side. Our MLRS missions did play a role, but it was primarily counter battery. You'll hear on the command tape "cue the radar, cue the radar" in conjunction with incoming Iraqi artillery arriving on the cavalry positions in less than 2 minutes throughout this battle, I cannot find anything that exceeded 2 minutes, when the MLRS turned off the Iraqi artillery. The time link between firefinder, the MLRS FDC, and the delivery of fires was extraordinarily short. I'll also tell you now, when you see the Iraqi artillery land, they did not close hatches. The cavalrymen did not close hatches, they drove with open hatches with their heads out of the turrets to press the attack. We will show you mine fields, and it happened like we show it, mines going off under their tracks, Colonel Krause mentioned to you, they pressed across the mine fields. I think what happened was Colonel Holder told them the only way home was through the Republican Guard and they believed him.

Q: Will we be able to understand the time sequence, from the screen?

A: Will you understand the time sequence? You will because I'll tell you. We do not now have a completely synchronized presentation for you. You are looking at our developmental product. To share with you, a window into where we're going and what we're doing. The reason I took you through that series of slides was to give you the sequence of the battle. We'll take you through the battle in the following way...when I turn the machine on, this screen will show...turn it on now. Bob, give me the plan view display, can you do that? This screen will show you where they are at 1530. I will run forward at 10 times speed on this without the out the window view to show you how they move forward and the routes they took to about 67.5 Easting. At that point, we'll go into a slower speed, where you can see the action as they developed the assault through the village and the times from about 1605 to 1607 through 1620. Then we'll speed it up and

take it to about 1930. We'll go back to 10 times. Once you've seen the battle, where you can understand the sequence, we'll then go back and I'll take you back to that 67.5 and we'll show you out the window views. We'll do little things for you like we'll follow a vehicle just before it launches a TOW. And when it launches a TOW we'll try to latch onto the missile and follow the missile into the Iraqi vehicle for you. We'll then hook onto Captain McMaster's tank as he crosses the ridge line and in front of him he sees a full battalion of dug-in T72s. You'll then hear his voice and the voices of his subordinates on the radio network as he orchestrates an attack through that battle. Then we'll switch off from McMaster's tank and go into the Iraqi array and show you the carnage that was wrought there within a matter of minutes. That's where we're going to try to show you the battle and my comments will be limited to telling you what you're seeing. Any other questions before we start?

Narration of Re-creation:

There are our soldiers as you see on the left of the screen. Right there, all three troops jumping off 1530. Enemy security forces, you'll see here, are encountered early on in this battle, they are eliminated and the troops continue the march. Their mission, find the Tawakalna Division.

Q: Can you point the village out? What's the name of the village?

A: (BLOEDORN) Right there. It's not a village, what it really was was a barracks. The Tawakalna was dug in on their training area. This was their Hoenfelds or Grafenwöhr and those were the troop barracks. They knew this ground intimately.

Q: Are you saying that the units were not aware of the situation at all?

A: (BLOEDORN) As far as we can determine, they did not know it at this time. Nor did our guys know where the Iraqis were. Visibility at this time has gone up to about 1000 meters in and out. Sometimes closed in to 600 but extending out to about 1000.

Q: There is one air report of the air troops taking fire the day previously from the village. That does not get transmitted to the troop commander?

A: (BLOEDORN) That's a true statement. The reports came in, we got the logs, we know it. There was also intelligence information in artillery channels but it did not get down to the troops. This was a mission called by Iron troop, artillery coming in clearing the way, very few rounds and they had a small effect on the battle. There you see the

rounds coming in...but that's a U.S. mission. Keep in mind this is 1000 meters a side of each square here.

Q: Is that purple burst supposed to be our artillery?

A: (BLOEDORN) That's correct. When you look out the window view you will actually see the bursts of the artillery.

Q: What was the reason for that fire?

A: (BLOEDORN) Iron troop saw these guys there and called for it and the fire mission went astray it landed there...so the U.S. stopped firing. It became one of our anchor points as to data locating the troops and what they were seeing and reporting to us. So the artillery did happen and that's why it's in this simulation. The right number of rounds and location are in the simulation.

Notice now as the troops have moved forward they have not changed their relative position at all. They are keeping very good station and they were very well aware of it even though the weather was bad. They were well drilled and the formation stayed the same as they moved. The enemy at this time, as Major Lute pointed out, was either stupid or asleep. But their recon elements simply could not see our people at all. Please understand that in our computers now, we have an electronic file for each one of these vehicles, we know who was in it, the crew members, we know its basic load, we know which operational systems were in that vehicle, we know exactly from beginning to end what that vehicle did. And that's what we're showing here.

Notice line of sight did not exist between that vehicle and here. Even though on this flat map it looks like it does. We walked the ground and interviewed and worked with the soldiers and then put them in actual simulators where they could look at this terrain data base and verify these locations.

Q: Why was Iron Troop so far behind Eagle?

A: (BLOEDORN) They're in another squadron. The squadron commander was having them move at a slower rate and you'll see a gap start to develop. Notice the scouts have just fired at the village. They took fire, located the enemy and started to shoot at a trench line that exists just around the village right here. So the action has now started with Eagle Troop in this location, Ghost is still moving in the north, Iron is now moving slow and you'll see a gap that develops between the two troops. At this time, there's a slight pause in the area, enemy coming out of the bunker...trench line around the village...started

to surrender and the scouts down here in 3rd platoon of Eagle had to take those people prisoner. Remember this is now being shown to you at 10 times speed.

Scouts up north spot reconnaissance elements and take them under fire. Again, notice when they shoot, they hit. No use of artillery, no use of mortars, no use of air. Straight gun fight. Down here Iron has made its first contact, you see they bring the fire power to bear, they shot quickly.

Q: What did they just fire on?

A: (BLOEDORN) Which one is that, sir?

Q: The one just fired upon.

A: (BLOEDORN) These MTLBs are rec naissance elements of the brigade of the Tawakalna. They're out forward, supposedly to provide early warning. Our people found them in that location, selected to provide early warning to the brigade.

Q: Why was the enemy not alerted?

A: (BLOEDORN) The information was either not believed or not acted upon. My judgment is that they did not get any message off, they just simply died before they could effect the battle. Keep in mind the Bradley fighting vehicle dog house for its thermal sight is about 13 inches higher than the M1s. So the Bradleys could see these MTLB through this stuff at longer ranges and pick them up quicker and the TOW missiles were dead reliable. When they fired the TOWs they went where they shot them. Here comes some mortar fires, it was fired here on this outpost. There was a bunker complex in there and the mortars from Iron troop are firing in support of the troops' advance and suppressing the reconnaissance elements of the Tawakalna.

Now at this stage, Captain McMaster is bringing his tanks forward. That means he's going to fight. He's bringing his M1s up now as we go back in time. Scouts are still protecting the southern flank and now we see the battle opening up. Captain McMaster is up forward--he fires three rounds in seven seconds. Three first round hits. Watch now as the battle develops, watch how the tanks lead and go through the Republican Guard. Straight on through, firing on the move. Iraqi vehicles turn white when they are destroyed.

Remember, I told you earlier in the still slides that Ghost, up here in the north. We'll show you that battle shortly. Ghost troop is coming upon the 73 and getting ready to start its fight. Iron down here, eventually catches up and goes through this entire defensive array. And does exactly to them, what Eagle did to the enemy forces up here. We have not

finished the Iron simulation and they will drop out of the presentation today. I just want you to know they did fight and they went through the whole battle and did exactly what the other troops did.

Q: Ghost and Eagle are two units?

A: (BLOEDORN) Yes, and that's Ghost. Can you shift your focus now and give me Ghost up there on my plan view display? We'll take you up a little bit and show you what's going on. Here now you can see the Ghost troop under Captain Sartiano coming up on the 73 Easting and just now starting to run in here while Eagle is past the village with its tank force and going through the Republican Guard. Iron has yet to come up. No one knows that. These guys are here. 18 T72s and a BMP sitting right in this area.

Q: Surely those guys must have been awake by now.

A: (BLOEDORN) Yes, we know they were awake and a little while later you'll see them open fire on the U.S. forces, bad mistake.

Q: How far into the battle are we now?

A: (BLOEDORN) At this time, right now, you are at about 1620-1623 into the battle. We started off at 1530, good question, thank you.

Now notice up in this area, we have blue elements lagging behind. They ran into a mine field, two of them got stuck there. The Lieutenant went up here to join them on the 73 Easting--he had the GPS and didn't want his vehicles wandering around the desert without a GPS so we went back to get them. Now you're seeing him coming up. That's Lt. Hains. He plays a very significant part in this battle and I'll point it out to you shortly.

Q: At 69 there were two vehicles left alive.

A: (BLOEDORN) What happened to those vehicles is that we found them in the simulation--they hadn't finished their fire target pairings yet. Those vehicles were knocked out but what happened is that they survived and fired on the scouts who shot back and got them. Thank you. Those vehicles are there. That's the correct location they haven't completed the software on the fire target pairing.

Now as Sartiano is on this location, shortly you will see him open fire. Eagle is through the first target array and is going after reserve forces, Captain McMaster is still not aware these reserve forces are there. Shortly now you'll see the gunfight starting in the reserve battle position. You'll see the gunfight starting here and Lt. Hains comes down

and starts to engage the reserve Iraqi positions at close range. So instead of the reserve battalion exploiting its positional advantage between two US troops, the cavalry comes down and envelops them. The battle opens up here at a range of 300 meters. Now you see, Eagle has found those guys and has started shooting, and look how quickly they all turn white. Ghost troop up in the northern portion. Ghost is fighting on the 73 Easting now from a defensive position. When the smoke from the burning BMPs obscures their line of sight the tankers move forward through the smoke, overrun Iraqi bunkers, and develop a lot of dismounted action. They kill everything out there, in a matter of about 10 minutes.

Here you see how the battle is starting to come in here, and the Iraqis are revetted, they are very heavily dug in in this location. Again, you can see the unit taking position, firing at vehicles. Iraqi artillery is coming in now. We do get some artillery into this area on the enemy forces. Notice Iron has dropped out only because we have not finished the software. Iron does go through and does exactly the same thing down here that Eagle did up there.

Can you bring me down now please to bring the Eagle down to about this location and get the northern flank of Ghost into the picture please?

Now the fight starts here. Notice Lt. Hains comes down, it is now dark. The burning vehicles are reflecting off the low cloud cover into an eerie glow of a Dante's Inferno type battle. Haynes and Sergeant Merriweather have come down and found the T72 battalion. Lt. Hains is alone on that battlefield with one other Bradley and they make the decision that well, that's why we're here...let's kill them. And they literally opened fire on dug in T72s at 300 meters. And my question was then, did you fire and move forward? He said no sir, it was more like we fired and backed up, fired and backed up.

Q: Is his a Bradley or an M1?

A: (BLOEDORN) He is in a Bradley.

The first missile that he fires goes out about 10 feet and detonates directly in front of his vehicle, the propellant motor failed. The second one he fires, hits a T72 and the explosion and pieces of the turret come back and land on top of his carrier. That's when he decided it might be smart to put it in reverse. He also reports that these guys are firing at Echo. He's down there trying to find the Eagle Troop, and he just ran into T72s and decided that it's time to kill them. He looks like Wally Cox, small, literally mild mannered, he's an absolute tiger out here. Echo sent Lt. Petchack and their first platoon up to find

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Lt. Hains so now we've got four Bradley fighting vehicles wandering around in front of a T72 battalion. It's at this time the testimony and the target examinations verify that the Bradleys started firing into the T72s with 25mm SABOT ammunition and 25mm high explosive tracer. Three Bradleys would pick a T72 out, hold the trigger down until they got penetration and they would get wisps of smoke and start it on fire. Then they found out if they used high explosive incendiary tracer that would scare the Iraqi crews and they'd jump out and run. So they switched from SABOT to high explosive incendiary tracer, and they'd get these loud explosions on the side of the armor and the crews would abandon their vehicles. So they were doing a little bit of tactics development in the field.

In the meantime, up here we have a little piece of ground that separates the battle. Capt. Sartiano can see either that side or this side. I walked the ground with him and inspected all these holes. So he's got a two platoon battle. He goes up here into the northern sector, and here's where the counter-attacks come in. If any of you have read the battle of 73 Easting accounts in the Stars and Stripes and all about Ghost Troop and the desperate Iraqi counter attacks this is where they occurred. I want to echo General Funk's comments that it looked easy but it wasn't. The battle here in this area was a series of attacks now, you can see the fire coming in. (If you can shoot me up there please, take me up to that location). Echo is quiet now, our friends in Iron are coming up and finishing their destruction and the Republican Guards Tawalalna Division is moving to attack Ghost. What you must understand at this time, I do not have it in the simulation, it was out of my mandate, but behind Ghost is Hawk Company (H company)--it's a tank company. There are 14 M1s. Behind both Ghost and Eagle is another reconnaissance troop. Colonel Kobbe, the squadron commander, is present on the field and in his battle tank as is his S3 and a Sergeant Major. Only 50 percent of the squadron has been committed, most of his combat power is uncommitted, and he has destroyed a good portion of this armored brigade, with two of his reconnaissance troops. What was the Colonel doing? My God, here is Ghost out here all by itself, you'll see the counter attacks coming in, waves of armor from his front, the dismounted crews of the destroyed vehicles to his front are rallying under the cover of darkness and making a series of dismounted attacks. It is at this time we lose the only vehicle the squadron loses in this fight, Sgt. Mollar was killed in Ghost 16 at 1648 hours. He was a little bit too far forward and took a 73mm round on the front of the turret. The first round did not penetrate. The Bradley took a second round in the turret, where it penetrated and killed Sgt. Mollar. The fixed fire extinguishers went off and the vehicle did not burn, the crew evacuated, the sergeant was killed. But the mass counter attacks were coming and still the squadron commander does not commit his

reserve. 3rd Armored Division wasn't up yet and he had no idea what the night held. Ghost was holding the position, was killing everything that was coming in, and the squadron commander absolutely kept his cool, sat there and watched the battle, and did not interfere. The battle shows no evidence of his interference at all, even though he was present and these troop commanders fought the battle with the resources at hand and they won.

Q: What is this artillery fire?

A: (BLOEDORN) That is Iraqi artillery, thank you. The Iraqi artillery was supporting this counter attack coming in from the north and again we had MLRS counter-battery fires that turned it off in about two minutes.

Q: Any air support at any point in this?

A: (BLOEDORN) Yes, the air was working out east of the regiment. But there was no air support called in on these formations. The direct fire weapons supported by their 4.2 inch mortars were all that was needed to stop the counter attacks. But air was not working in the area. Remember, the weather was so bad that air was not really a factor and as you see the battle...I caution you once again to remember, we're going back now to look at it visually...we're going to see segments of it. This is a very unusual fight, it's a long-range gunfight. They didn't fire many rounds, but what they fired was very destructive, it was almost binary. They pulled the trigger, an enemy tank blew up.

KRAUSE: There is one element that I would like to just mention, and that is the serendipitous actions of two one aviation that is that aviation battalion that was used in support of the regiment when 130mm artillery fire begins to hit. I don't think you put that in yet...this Apache squadron flies through this weather at 200 feet. Visibility max 1400 does not see its own platoon to the left and the right and is able to hit about the 78 and 80 Easting of this artillery position that has impacted on Eagle in some cases.

A: (BLOEDORN) Thank you, Colonel Krause.

Q: Any fratricidal events?

A: (BLOEDORN) Iron troop took a TOW missile from Killer on Iron 14. It hit the vehicle, the crew had four wounded, they evacuated and had electrical fires later on which caught some ammunition on fire, causing the vehicle to burn. It didn't burn with the initial impact and no one was killed. It was the only fratricide incident in this entire area.

So we had one killed, four wounded out of the three troops as they destroyed a heavy brigade.

Now tomorrow, we will discuss all of the data, how we collected it, how we analyzed it, how we participated with the soldiers. But at this time I would like to make two points to you before we go looking at the battle from a perspective view. We will actually join the troop and listen to the chain of command. You are looking at their reenactment of the fight. We use the technology to take them back to Iraq in the simulators. They re-fought the battle under their own chain of command and they did all of the correction and then we compared it to overhead image sources and things of this nature. We will get into that tomorrow, so just try to comprehend the level of detail today and how the battle was actually fought. Are we ready to go to the out the window view? All right, we're going back to the point where Eagle Troop comes up to the barracks and they fire at the trench line from the barracks with their 3rd scout platoon. We are going to go back in time, come with me to the thrilling days of yesteryear...and we will watch the first scout platoon. We'll try to catch the missile in flight as they start the engagement, you'll hear the chain of command and there's some very interesting things happening here. The scouts are firing across the front and you'll hear McMaster telling them to cease fire, cease fire. He doesn't know at this point that the brigade of the Tawakalna is to his front.

They'll fire up the village, we'll try to catch those missiles for you. Then we'll join Capt. McMaster on the top of his tank...we'll ride with him, and watch that initial engagement as he crosses the ridge, you'll see the array of enemy armor that pops up. Now we do not have for you today the thermal data base and we I don't have the defensive trenchs and berms in, but keep in mind it was thermal hotspots they were seeing. Lots of dust and dirt out here. We'll ride through that initial attack and then we're going to take in the Iraqi position and we'll take you into the area and let you see the carnage that these few moments of gunfire actually wrought. You can see the Americans coming in. I do this to try to get your imagination going on how we can use this technology for analytical as well as historical and training purposes.

You'll see the battle again out in this area. (Can you wind forward there and get me up to the 67.5)? And then you'll see it out the window.

Q: I have a question about the ammo...I thought that later in the fight the tanks had to come back and resupply for ammo? Is that true?

A: (BLOEDORN) No, what they did was they cycled them off from the battle line to cross level ammunition in the vehicles. What you've got is ammunition down in hold storage and you've got TOW missile systems that are not readily available. These were modified M2s so what they had to do was they pulled back off the fighting position and they'd go through what they call an ammo reload drill. They take ammunition out of storage compartments, put it in the ready racks, reload their weapons and then pull up on the line. It was extraordinarily small expenditures of ammunition. Col. Krause and the team and I walked the actual firing positions, counted the brass, the spent brass and followed tow wires from launch positions in the targets. They really fired very little ammo. It was not like any battle you've ever seen. All right, let's go back and see if we can't join them now...

Q: The voices that you have recorded, are they actual recordings?

A: (BLOEDORN) Let me explain that. What they did was record on the FIST-Vehicle of the units as they move so we got the fire support nets as well as the command nets of the troop and the platoon responses. They had a tape recorder going during the actual battle. You'll be hearing Capt. H.R. McMaster, Lt. Davis who is the FIST, and a few vignettes of the battle might be appropriate while we are sorting out the technology. The FIST is in a M113, a very light skinned vehicle. We find the fist field artillery officers assigned to the howitzer battery of the squadrons. They stayed right with the main battle tanks during this fight and right up there hazarding their little bodies. You can hear on the tape the 50-caliber machine gun firing. What you will be hearing are the actual recordings that we brought back. I still have to do some more noise filtering, some enhancing, with the computer labs to get it as clear as we want it, but we thought you'd like to hear it as data points and anchor points that Jack talked about. We would like to expose you to the kind of material we're working with. We have a famed historian up here--Trevor Dupuy. Trevor understands that you have to bring this stuff out, examine it, cross check it, cross-reference it, and voice commands and reports of positions help us anchor locations. We'll talk to you about that in depth tomorrow.

We're now flying over the troop. Notice the arrow here on the plan view display which shows where your viewpoint is. Bob is taking you on a tour just before they open fire of what it looks like out there and where our troops are. Now they've opened fire, you're getting your first combat going here. Now he'll take you down and show you how the troop develops the situation. You can see the muzzle flashes as they're firing into the village. Notice each round is accounted for both here and out there in the real world--or

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our simulated world. From the very first moment of the battle we are starting to get burning vehicles and a lot of smoke out there. What I'm going to do now is take you back down to the scout unit up here. We're doing time travel now. We are going to take you back in time and back up to this vehicle and show you how that action developed, which is literally the first battles/rounds that Echo fired.

Again, time travel. We're going back now in time to show you how the battle comes up and we'll show you how they fire from the northern element of the unit and get in on the enemy.

That was the company commander gently chiding his warriors...(laughter). (Bob, want to try that one again)...What happened was, he was trying to catch the missile in flight. You saw the impact, and what we're trying to demonstrate to you is the technology as opposed to the battle. So bear with us for a moment and Bob Clover is going to try that again.

There goes the launch...I told you that ammo was powerful...(laughter) All right now we are on the company commander's vehicle, our point of view is coming right behind the unit commanders vehicle. We just spotted them...we're going to take you forward now and show you how it looked on the Iraqi side about three minutes or four minutes into the fight. Your viewpoint is right here, Bob, if you can get low to the ground, take us down to the ground and then, there's your viewpoint, looking into the enemy's positions from their point of view back towards our soldiers. Bob, take us up a little closer into that if we can. There you go. Each one of these represents an actual engagement that happened that day.

As we pointed out, we are in the middle of developing the technology. We used this battle and took it back to the troops in Germany and they went through this for three days. We'll identify for you tomorrow all of our data sources, but the point that I was trying to make here is that once you've digitized the data, now you can start doing printouts of rounds fired, probabilities of hit, we have all of that. But more importantly, you can, in fact, enter the battle at any given point in the battle, you can do your time travel and as Jack Thorpe pointed out earlier the eventual application is when we start to change one of the parameters. We put a lieutenant in, another unit in, they change their course of action, we put another officer in the Iraqi side who is more aggressive, what happens if the U.S. forces did the same thing. Trying to stimulate your thought and your ideas on what's going on here. The complete battle that you saw in the slides and that I showed you in 10 times real time is being subjected to the treatment of one round, one target, all the

minefields will be in, dismounted infantry will be in, each individual engagement, mortar firing, the simulation should be complete sometime around the first week of October. Any questions you have of me, of the battle, or the treatment we have given it in the technology?

Q: Did you get any information from military intelligence more or less what the Iraqis were doing?

A: (BLOEDORN) Very good question. Take you back to Maj. Lute's comment. He almost made it in passing, but it was a very important comment. They didn't capture many of the Tawakalna division. They died. There are two misconceptions of the war. One that the Iraqis did not fight. I can assure you that the Republican Guard fought almost to a man here but we didn't capture many of them. None of their vehicles survived. I could not identify any of them that got away. Col Krause mentioned the 3,750 meter shot first round kill from moving tanks. The casualty rate of the Iraqis was horrendous. All we got were privates and few of those. Not many reports. But one of the defects in our system is getting EPW reports back to the historians. So, the question is absolutely the right question. But because they took such heavy casualties, most of this input is on their side and that information that we have on EPW's is yet to be made available to me. But I'll discuss all of our data sources again tomorrow in some detail for you.

Q: I noticed that your picture out the window has about, oh, 25 miles visibility, I thought you were talking 200 meters visibility maximum.

A: (BLOEDORN) Yeah, exactly right. But it wasn't 200 meters, it started off at 600 meters and went out to about 1000 and later when it got down in the evening the wind stopped and visibility was limited by ambient light as opposed to dust. What you're looking at is the developmental data base where we're using it to establish the movements, the target fire pairings, the juxtent position, the location of all the forces. We are at the same time, developing the terrain databases which carry the visibility conditions, the ambient light conditions, and the ancillary operations and I will discuss that again. I don't mean to put you off. You're exactly right. It's a developmental data base we're letting you look at it as we see it and use it as a developmental tool. Fair?

Q: Did the T72s have any reactive armor?

A: (BLOEDORN) You saw them. No, they did not. But they did have the T80 armor package on about 30 percent of them. It did not seem to make any difference at all. The T72 with the T80 armor package are versions called the Dolly Parton, Gen. Bob Sennell sitting in front of you is the officer who developed the depleted uranium

round. We have evidence, physical evidence of rounds fired at over 2000 meters going through four feet of earth and then through the front slope of the Dolly Parton version of the T72, took the engine out, ripped out the back armor plate, threw the engine 200 meters out into the desert and moved the tank back eight feet.

Q: Could you explain a little bit about the event that you just described with that round and to what extent you are simply replaying that sequence from your historical database as opposed to simulating the impact of a round against a tank object?

A: (BLOEDORN) What we're doing is not simulating the impact of the round on the tank object. What we're doing is actually re-enacting the battle. What I'm literally doing is when the round hit that tank, we have on our data sources what was target effect. Then we go out and photograph the target, looked at the target, worked with the foreign science technology center people, they happened to be up there at the same tirr : we were, and so we know what the round did. We've got a pretty good idea of what killed that tank, so what we're doing is showing you that that tank went up. Now the special effects going into the simulation, will go further. Those tanks have lost their turrets, and in our simulation will lose their turrets. Those tanks that simply burned, burned. But in every case, they either lost their turret, or they burned. The effect was catastrophic. The Second Cavalry made it kind of easy because they did live by "if it ain't burnin', it ain't dead". And they put another round in it until it did burn.

Q: So the difficulty that you may be having as you carry this technology forward if I understand it, is going from your undergraduate time work to your graduate time work from a historical base of limited algorithmic simulation and then taking that data and now going forward so you can play what if?

A: (THORPE) Yes. For this current version we are re-creating the simulation that calculates ponit of impact from a certain amount of steel and results. We play what actually happened. Ground truth. The new level, the "what if" version that you refer to, is different and not necessarily connected. We could do this in real time or in fact non real time. Also we could provide physical interaction. This would require greater development, which we may or may not do in the future.

A: (BLOEDORN) As an example. I could take the armor package on the M1A1 against that same round. Place the M1 in that position, and the M1's target acquisition rate of fire that we know went on this battlefield, fire into that M1, not kill it and then allow that tank to wreak the havoc that it could wreak and see what the result would be. Fair?

Q: How did you decide which round killed the tank?

A: (BLOEDORN) Exactly the right kind of question. And I am prepared to answer it if you'll hold it for me. I've got the charts and the data for tomorrow. That's what we're devoting that time to, how we did this.

It is our intention to expose to you our methodology. We do indeed want to tell you those things that Jack Thorpe said "these are our anchor points," "these we know with absolute certainty," down to "those are ambiguous and are completely unknown." We're prepared to do that and we have gone through a great deal of effort to do that, because that is really the purpose of the conference. To show you how we married the emerging microprocessor technology that Vic Reis talked about, with our emerging capabilities, historians and simulation designers to get this kind of a record. This gentleman here expressed his concerns today about all the varieties and the various interchanges, the second, third and fourth order interactions that go on a battlefield, how do we handle all of that. We hope to address those issues head on with you tomorrow. We think we will have a very interesting give and take discussion on that.

Q: When I heard you talk of the "what if" concept, my imagination said well supposing this was good weather, and you might have had air strikes, helicopters? Is that what you are presenting tomorrow? And do you have a concept for doing that?

A: (BLOEDORN) That is certainly part of it. Yes, sir, we have a concept and I'll expose you very quickly. If you understand that each vehicle is an electronic file, we know where it is, we know its condition, we know what the type of system it is, we know where it's going and what its hit probability was. If I then take the data packets off the network and I take an associated manned simulator of a futuristic system like we have at Fort Knox, the M1A2 and that becomes the initialization data for the M1A2 at Fort Knox, I can man that with soldiers that have new doctrine and tactics that have been developed for the new piece of equipment and from that point I can start to fight. I can take the red force and associate each one of the predetermined Iraqi vehicles with a semi automated force vehicle that we use as artificial intelligence controlled froces, select what its level of proficiency is and refight the battle from a given set of conditions that are variable. That way we control the variable, and we can see what the difference is. Does that answer your question?

Q: You might mention to him the resolution you have attained.

A: The speaker is Lt. Gen Brown, who was the commanding general of the Armor Center. When we started this he was deputy chief of staff for training at TRADOC

and then became the commanding general of the armor center and has participated with Col. Thorpe and me in the development of this from the beginning. What he is saying is that when we built SIMNET and all elements of it, these are not simple representations of icons. Each one of these vehicles has an electronic history. We took the operational test and evaluation data of the M1 tank and that's buried in the software. SIMNET tanks break down, as normal M1's do, they can consume fuel, as normal M1's do, they have an armor envelope, the have a rate of fire, we took the acquisition paradigms, etc. SIMNET vehicles have this performance data in them, so do the enemy vehicles. So that if we were to vary performance, that's another level that we can vary when we use it for a combat development purposes. Does that capture the thought, sir?

Q: It seems your PK data here and BRL/AMSAA data are massively different than what AMSAA has been pushing on the OT&E and Simulation communities for the last 20-30 years and could have a big impact on a lot of studies.

A: (BLOEDORN) My information is that these agencies are now conferring with the Soviet General Staff and coming up with a story...(laughter)...You're exactly right, General Funk said it today and I would like to reinforce it. None of us, zero, me, no one in the theater, nobody, thought these soldiers could shoot like this. The story I get from massive interviews with these guys. Tank commander after tank commander, they had not even fired a single round of the new depleted uranium long rod penetrator before they went to combat. They were given the ammunition with a correction factor for their computer. They applied the correction factors, they lased, they pulled the trigger and got spectacular results. Period. They said just like table 10. Just like table 12. The ammunition, General Sunnell can talk this much better than I can, was dead accurate. The tables of hit probabilities were wrong. Our soldiers, the training that General Funk talked to you about, he talked to you very seriously, he meant it, the personnel performance here was something that exceeded any of our expectations. No one except the Captains, Lieutenants and Sergeants knew they could do this, literally. This is a big surprise.

--73 EASTING--

TUESDAY, 28 AUGUST 1991

--73 EASTING--

METHODOLOGY

Major James Wargo, USA
Defense Advanced Research Projects Agency

JIM WARGO

Good morning, my name is Major Jim Wargo. As Jack said, I am the DARPA program manager for Project 73 Easting.

As a point of reference, I think it is useful to note that this is a working conference. Yesterday was an excellent presentation of the battle. Today the work starts. What we hope to do is detail, as Jack said, the efforts that went into constructing the battle. Again, as a point of reference, yesterday you heard Col Krause--the historian's view of the overall battle. General Funk presented his view, his perspective as the 3rd armored division commander, followed by Major Lute as the squadron commander and finally Gary Bloedorn presenting the detailed vehicle-by-vehicle recreation of the battle from his historical perspective.

First Slide...I feel obligated to present the program managers historical perspective. Again, in simple terms this was our objective...I don't know if you're a fan of comedy, but even if you are not, you might be familiar with the routine done by Father Guido Sarducci from Saturday Night Live in which he proposed the five minute university. Instead of cramming four years of education into five minutes, he was going to teach precisely what the average college graduate remembers after four years. He didn't address the topic of history and I am an engineer, so in all deference to the historians here, I will now present what I remember after X years of education in history.

May I have the next slide. The first lesson is that history is important. That is sufficiently non-controversial so without a show in hands I will say that we have a consensus. There are a lot of lessons to be learned. This program has its roots in the then Vice Chief of Staff General Sullivan's request to document a battle for that very purpose. Lessons Learned.

Next Slide. History is based in fact. Unless you can believe what you see, it is fiction. At the time, the facts may be confusing, especially if you are in the middle of the battle, and I'm glad that the participants in the 2nd ACR probably weren't thinking about it at the time. They have now had time to reflect. The most telling quotation is the one at the bottom. "Unless you can believe what you see, it is fiction and fiction is only good for entertainment."

Program Purpose

To re-create the events and timelines of that battle fought by the 2ACR against elements of the Tawakalna Division of the Iraqi Republican Guards on 26 FEB 91 vic 73 Easting

Session Purpose

To describe in detail the methodology used in the simulation of the battle

- **Database Development**
- **Data Collection**
- **Data Reduction & Analysis**
- **Simulation Construction**

History Is Important

"Those who cannot remember the past are condemned to repeat it."

George Santayana

"A page of history is worth a volume of logic."

Oliver Wendell Holmes

History Is Factual

"History is a confused heap of facts."

Lord Chesterfield

"History never looks like history when you are living through it. It always looks confusing and messy, and it always feels uncomfortable."

John W. Gardner

"Truth is the only merit that gives dignity and worth to history."

Lord Acton

Next Slide. The third and final point is that history is subject to interpretation. To paraphrase General Schwarzkopf, I am not a historian; neither am I a tactician or a strategist and I am not schooled in the art of doctrine. But I'm an engineer and I know how to assess a tool and I think that's what we've created. With the rest of this morning, what I'd like to do is piece-by-piece describe to you the details that went into construction of this, so you can assess for yourself what you can believe. I think what you'll find after all this is said and done is that we've gathered all the information available and incorporated it into a very fine or very innovative format for review and perhaps later, update. The first speaker will be Mr. George Lukes, George is the chief of the autonomous technology divisions at the research institute at Fort Belvoir. He did his undergraduate work at Cal Berkeley and his graduate work at American University. His primary interest is in digital terrain research. He is responsible for all of the data base constructions. George will present in agonizing detail exactly how that was performed. George says he's willing to entertain questions during the course of the presentation.

History Is
Subject to Interpretation

"All the ancient histories, as one of our wits has said, are but fables that have been agreed upon."

Voltaire

"It has been said that though God cannot alter the past, historians can; it is perhaps because they can be useful to Him in this respect that He tolerates their existence."

Samuel Butler

METHODOLOGY: TERRAIN DATA BASE DEVELOPMENT[1]

George E. Lukes

Research Institute

U.S. Army Topographic Engineering Center[2]

Fort Belvoir, Virginia

INTRODUCTION

Digital reenactment of the Battle of 73 Easting in distributed simulation requires a terrain data base with sufficient resolution and fidelity to represent tactically significant spatial relationships within and about the battle site. The approach builds on components of Project ODIN, a rapid response initiative for Operation Desert Shield by the Defense Advanced Research Projects Agency (DARPA), that included capabilities for three-dimensional visualization of the Kuwait Theater of Operations using SIMNET computer image generation (CIG) technology.[3] In support of Project ODIN, the U.S. Army Engineer Topographic Laboratories (ETL) had constructed a large SIMNET digital terrain data base for the Kuwait Theater of Operations that included 73 Easting battle site. For operational convenience, a tailored 73 Easting terrain data base was extracted from this much larger SAKI (Saudi Arabia-Kuwait-Iraq) terrain data base and then intensified to incorporate features of tactical significance (e.g., berms, bunkers, trenches, barracks) using information collected from field survey and reconnaissance imagery.

This paper initially focuses on the construction of the SAKI terrain data base. The primary source materials [e.g., Defense Mapping Agency (DMA) Digital Terrain Elevation Data, maps, remote sensing imagery] are described and followed by a discussion of representational issues in a SIMNET visual data base.[4] For this type of computer image generation, all objects--terrain, buildings, tanks, smoke, fire--are modeled as polygons colored by generic "texture maps." Work subsequently performed to intensify the 73 Easting terrain data base is then presented. This effort included field work in Iraq at the battle site and image exploitation conducted at the Army's Terrain Analysis Center (TAC). New features incorporated into the baseline terrain data base--individual tank berms, crew bunkers, trench lines and barracks--are illustrated. The paper concludes with a brief discussion of lessons learned.

Distributed simulation has the inherent power to tightly bind many individuals, potentially from very different backgrounds, in a closely shared experience. Reconstructing the Battle of 73 Easting has involved military historians, tacticians, computer scientists, animators, terrain analysts and technologists as well as soldiers of the

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[3] To support Project ODIN, the Army loaned two BBN GT101 CIGs that were scheduled for use in new SIMNET M1 tank simulators at Grafenwöhr, Germany.

[4] In addition to a real-time visual ("out-the-window") data base, special versions of the terrain data base are compiled as a two-dimensional (2D) electronic map and to support Semi-Automated Forces (SAFOR).

2nd and 3rd Armored Cavalry Regiments. Interest in the reenacted battle also extends to other communities including those responsible for military training, analysis and operations. The goal of this paper is to provide a common understanding of the methodology, constraints and jargon that underlies the construction of the digital terrain data base.

SAKI TERRAIN DATA BASE

SAKI Terrain Data Base Extent

The SAKI (Saudi Arabia-Kuwait-Iraq) terrain data base encompasses all of Kuwait and adjacent regions of Saudi Arabia and Iraq. The SAKI terrain data base spans an area of 360 kilometers east-to-west and 290 kilometers north-to-south. It is more than twenty-five times larger than previous SIMNET terrain data bases such as Fort Knox and Fort Hunter-Liggett. Accommodating this expanded size required significant modifications to the data base construction software, development of new compilation procedures, much larger mass storage devices and close attention to geodetic coordinate representation and conversion.

Geodetic Frame of Reference

SIMNET terrain data bases are built in a Cartesian coordinate system referenced to the Military Grid Reference System (MGRS or MilGrid), the military variant of the Universal Traverse Mercator (UTM) geodetic system. For the SAKI terrain data base, more than 85 percent of the area lies west of 48° East longitude in UTM Grid Zone 38R while the remaining area including Kuwait City lies in UTM Grid Zone 39R. To provide a unified internal frame of reference, the SAKI terrain data base was built on UTM Grid Zone 38R extended throughout the full area. Rigorous mathematical transformations are used to convert between geographic coordinates (latitude and longitude) and UTM grid zones as required. Two-dimensional (2D) electronic and paper maps, for example, display gridlines in either Grid Zone 38R or 39R corresponding to the standard DMA Topographic Line Maps and chart conventions.[5]

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5   The error introduced by this approximation should be less than a few centimeters.

INTRODUCTION TO SOURCE MATERIALS

A wide variety of data sources were used to construct the SAKI terrain data base. Digital data such as the DMA Digital Terrain Elevation Data was processed directly.[6] Digital feature data was captured from topographic and image maps, charts and other hard copy sources using interactive digitization. Data base construction activities were initiated in August 1990 following the Iraqi invasion of Kuwait. At that time, efforts were underway at the Defense Mapping Agency and elsewhere to field updated map and intelligence products, but those products were not yet available.

Initially, available source materials included DMA DTED and a variety of topographic maps and charts including limited and dated coverage of DMA Topographic Line Maps (1:50,000), Kuwait topographic maps (1:100,000) produced by the United Kingdom and a variety of smaller scale maps and charts, tourist maps, guides and other collateral sources. Working with DMA and TAC in early September, a set of 1:50,000 Image Maps of coastal Kuwait were produced for Project ODIN from SPOT panchromatic imagery (nominal ground resolution of 10 meters/pixel).

In response to the crisis, DMA initiated expedited production of color 1:100,000 Image Maps based on geocoded Landsat Thematic Mapper (TM) multispectral imagery (nominal ground resolution of 30 meters/pixel). These were reproduced in quantity for distribution within theater and were quickly adopted as a primary source for populating remote areas of the SAKI TDB. Subsequently, DMA emphasized production of updated 1:50,000 Topographic Line Maps in response to priorities set by the Army component of the U.S. Central Command (ARCENT).

Digital Terrain Elevation Data

Digital Terrain Elevation Data (DTED) is a standard digital product of the Defense Mapping Agency (DMA). DTED represents the shape of the Earth's surface as elevation values on a regular geographic grid (units of latitude and longitude). This most widely available product, DTED Level 1. has a grid spacing of 3 arc-seconds at the mid-latitude which corresponds to approximately 100 meters post-to-post. In response to national priorities levied by the Joint Chiefs of Staff, DMA has produced extensive DTED Level 1 area coverage which is distributed in $1° \times 1°$ cells to the Services and Commands on

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[6] Standard feature data (roads, soils, hydrology, obstacles, etc.) encoded in DMA Interim Terrain Data (ITD) was not available until later in the war effort.

magnetic tapes or CDROM disks. Existing DTED Level 1 coverage of the Middle East was available at ETL and provided the foundation for rapid assembly of the SAKI terrain surface.

Topographic Line Maps

Prior to Operation Desert Shield, Kuwait and southern Iraq had not been DoD priority areas for DMA production of 1:50,000 Topographic Line Maps (TLM), the traditional map product to support American ground forces. Available DMA and other topographic maps of Kuwait were limited and dated. The national Kuwait 1:100,000 map series produced by the *United Kingdom* was used initially as one of several primary sources. As current image maps became available, these TLMs served as collateral material to confirm or identify features not clearly discernable on the image sources. As the new DMA 1:50,000 TLMs became available in the course of the project, they became a valuable primary or secondary data source.

SPOT Pan Image Maps

New 1:50,000 Image Maps were produced from SPOT panchromatic imagery in September 1990. Production of these maps in eastern Kuwait was directed by DMA under the sponsorship of DARPA and the ETL Terrain Analysis Center. For the SAKI terrain data base, the 10 meter resolution provided by these orthographic image maps was an important source for digitizing coastlines, roads, pipelines, runways and other terrain features. These image maps were also used extensively to place models.

Landsat TM Image Maps

DMA produced and distributed large quantities of color 1:100,000 Image Maps generated from geocoded Landsat Thematic Mapper (TM) imagery. The multispectral TM imagery has a spatial resolution of 30 meters. For SAKI terrain data base construction, these image maps were particularly valuable in the western areas where neither 1:50,000 SPOT image maps nor topographic line maps were available. Roads and terrain boundaries were digitized from these image maps. They also served as a visual reference to place models and apply terrain coloration and/or texture maps.

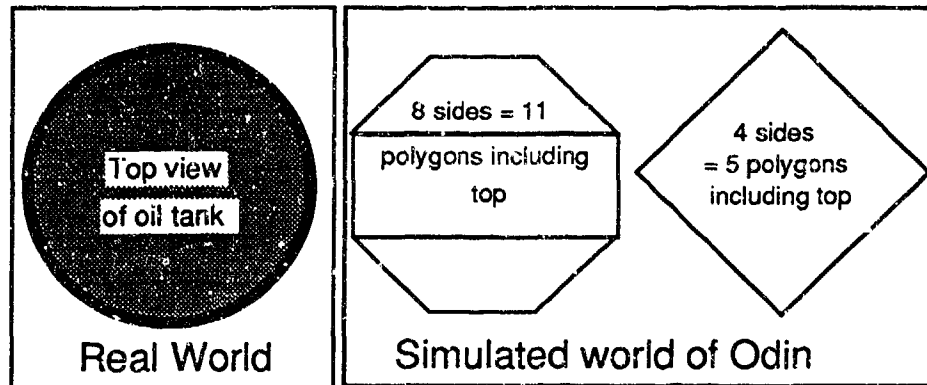# TERRAIN REPRESENTATIONS FOR REAL-TIME VISUALIZATION

The density of a SIMNET terrain is governed by design and capacity of real-time computer image generation (CIG) hardware and the demands to represent dynamic moving objects (e.g., tanks, Bradleys, helicopters, missiles) as well as terrain. The primitive data types processed by these CIGs are simple *polygons* and *texture maps*. The task then is to transform the digital elevation and feature data into 3D models composed of polygons and texture maps to represent a specific geographic region of the world.

Polygons

Polygons are used to represent all objects within a SIMNET visual data base. Within this context, a polygon is defined as a flat surface with 3 or 4 vertices, each vertex described by 3D Cartesian coordinates. One of 4096 colors or a texture map may be assigned to each polygon. Any computer image generator (CIG), such as the SIMNET GT101 CIG, is limited in the number of polygons it can display per unit time. A primary design objective of the data base engineer is to maximize the number of displayed objects by using minimal polygonal representations.

3 sided polygon   4 sided polygon
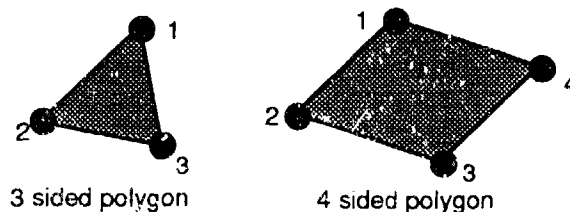
The designer must decide how best to represent shapes that are curved using surfaces that are flat. An illustrative example is a cylindrical oil tank. As seen from above, the oil tank is circular. What is the minimum number of polygons that will adequately depict this shape? As shown in the figure, a "four-sided" oil tank can be represented with five polygons while an "eight-sided" oil tank requires nine polygons. Based on the number of polygons available per scene, the data base engineer must evaluate the importance of the object, such as the oil tank, to the application, consider the number of objects present in any given scene and the polygonal density of other objects that will be placed in proximity and their relative priorities. Successful execution of such design decisions is critical in demanding applications such as Project ODIN or 73 Easting where visualization of many moving objects (e.g., M-1 and T-72 tanks) is a primary objective.
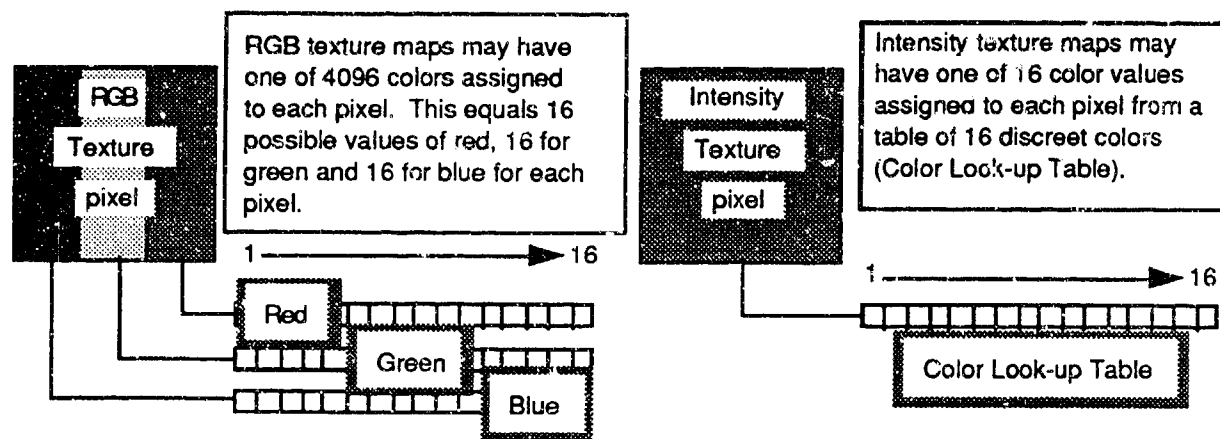
8 sides = 11 polygons including top

4 sides = 5 polygons including top

Top view of oil tank

Real World

Simulated world of Odin

Texture Maps

Texture maps are digital images composed of picture elements (pixels) as shown in the adjoining figure. Different texture maps are applied to polygonal surfaces like "wallpaper" to differentiate vegetation, roads, soils and depict special effects (e.g., dust clouds, explosions, smoke). Each pixel is assigned one of 4096 colors and 16 levels of transparency. Current SIMNET CIG hardware limits texture maps to 64 × 64 pixel images.
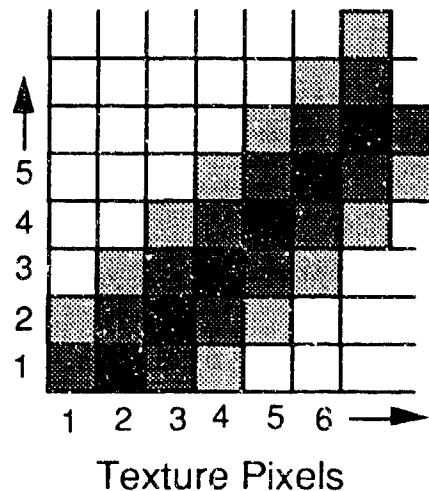
Texture Pixels

Two types of texture maps--RGB and intensity--are supported by the SIMNET CIG hardware. Pixels in RGB texture maps are assigned one of 4096 colors. Intensity texture map pixels are assigned one of 16 colors from the palette of 4096 colors through a Color Look-Up Table (LUT).

RGB texture maps may have one of 4096 colors assigned to each pixel. This equals 16 possible values of red, 16 for green and 16 for blue for each pixel.

Intensity texture maps may have one of 16 color values assigned to each pixel from a table of 16 discreet colors (Color Look-up Table).

RGB Texture pixel

Intensity Texture pixel

1 ————————➤ 16

Red
Green
Blue

1 ————————➤ 16

Color Look-up Table

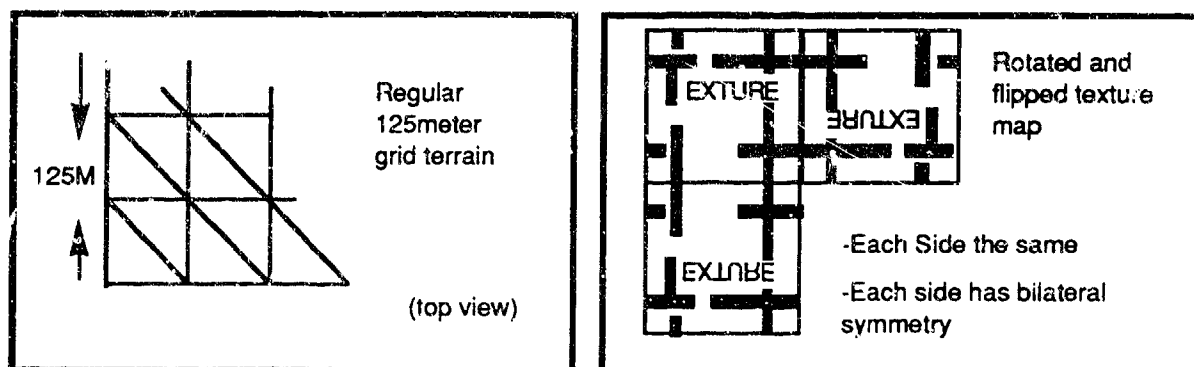## BUILDING THE SAKI TERRAIN DATA BASE

The SAKI terrain data base was built at ETL from the various source materials by specialists using the S1000 terrain data base construction software developed by Bolt, Beranek and Newman (BBN) under the SIMNET Program. The rigid constraints imposed by the target BBN GT101 CIG hardware drove data base design. Spatial extents and data base priorities were established by operational requirements. Following compilation of the real-time visual data base, correlated representations were compiled to create a two-dimensional (2D) electronic map,[7] a tailored set of data bases for Semi-Automated Forces (SAFOR) and Topographic Line Maps (TLMs). The discussion that follows focuses on generation of the visual data base to represent the terrain surface, features mapped onto the terrain surface, and finally the three-dimensional (3D) cultural objects placed on the terrain.

Surface Representation

The basic geometry of the terrain surface is created by transforming DMA DTED into the simple polygons required for visualization. Various surface conditions are then distinguished by texture maps projected onto the surface. The discussion that follows is organized to address representation of (a) land features, (b) coastal features, (c) surface vegetation and (d) roads.

Land Features. In general, land has been modeled by digital elevation posts on a regular 125-meter UTM grid. The primary data source was operational DMA DTED Level 1 derived from a photogrammetric source. S1000 software performed the necessary conversion from geographic coordinates (latitude-longitude) to UTM (Grid Zone 38R) and resampling to the 125-meter lattice

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7   In SIMNET, the 2D electronic map is known as the Plan View Display (PVD).
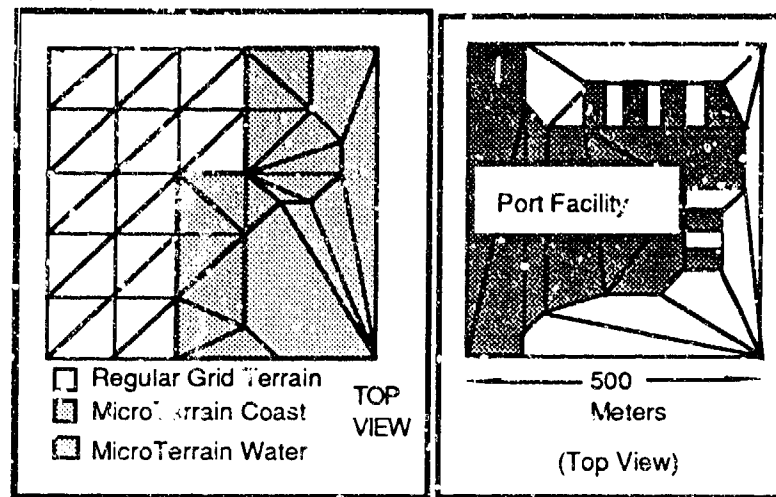
As shown in the diagram, the grid lattice is partitioned into right triangle polygons with texture maps assigned on a per polygon basis. Desert regions in the SAKI terrain data base were largely populated with a distinctive brown/tan texture map. Texture map patterns can be rotated and flipped to minimize visual artifacts known as "quilting". The gridded land surface can be replaced by irregular terrain surfaces derived from digitized features (e.g., contour lines, coastlines). In prior SIMNET activities, thi ¨ approach was known as "microterrain" and applied to the representation of small, high-valued areas.[8] In fact, microterrain is an example of surface representation by Triangular Irregular Networks (TINs) that is equally relevant to "mesoterrain" and "macroterrain". For the SAKI TDB, this capability was essential for detailing coastal terrain features.

Coastal Features. The traditional 125-meter grid did not provide the spatial resolution necessary to adequately represent the Kuwait coastline, ports, piers and associated coastal features. Existing S1000 tools for generating microterrain from digitized contour lines[9] were adapted to detail the coastline by digitizing the land-water boundaries identified in various source materials, primarily the SPOT Image Maps. The assumption was that many polygons would be required to capture the desired level of detail. The surprising result was the mean polygonal density resulting from modeling the coastline with TINs was comparable to the density of the traditional 125-meter grid. Coastline TIN polygons average 75 meter edges while open water is represented by 500 × 500 meter polygons.[10] Major piers and docks are partially represented by TIN polygons with an average edge of 50 meters.

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[8] SIMNET microterrain was originally developed to model individual berms between lanes in the Canadian Army Trophy (CAT '87) competition course at Grafenwöhr.

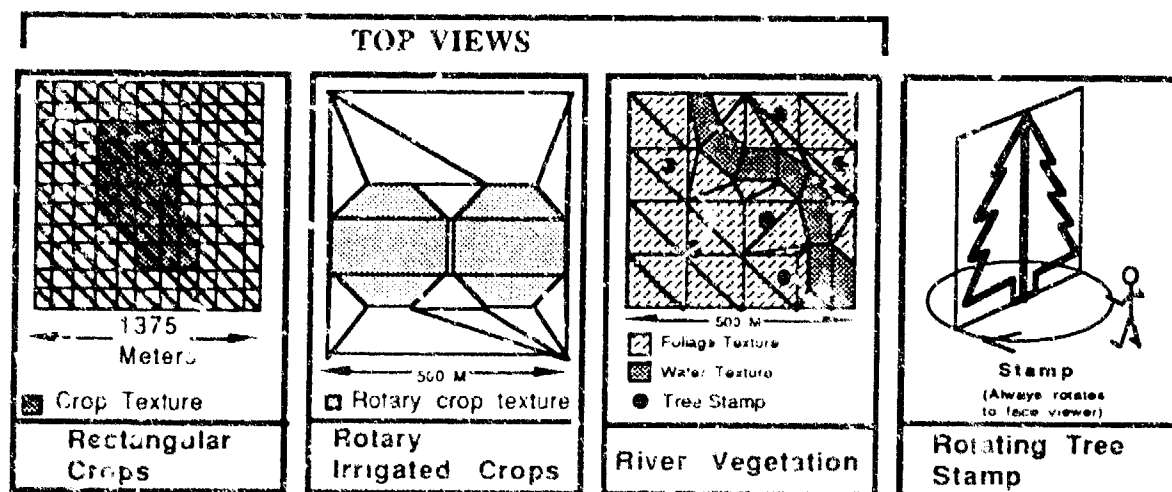[9] The coast lies at sea level corresponding to a contour line of zero elevation.

[10] SIMNET terrain data bases are partitioned into 500 × 500 meter load modules to facility traversal of large data base by low-cost CIGs with limited active area memories.

Regular Grid Terrain
MicroTerrain Coast
MicroTerrain Water
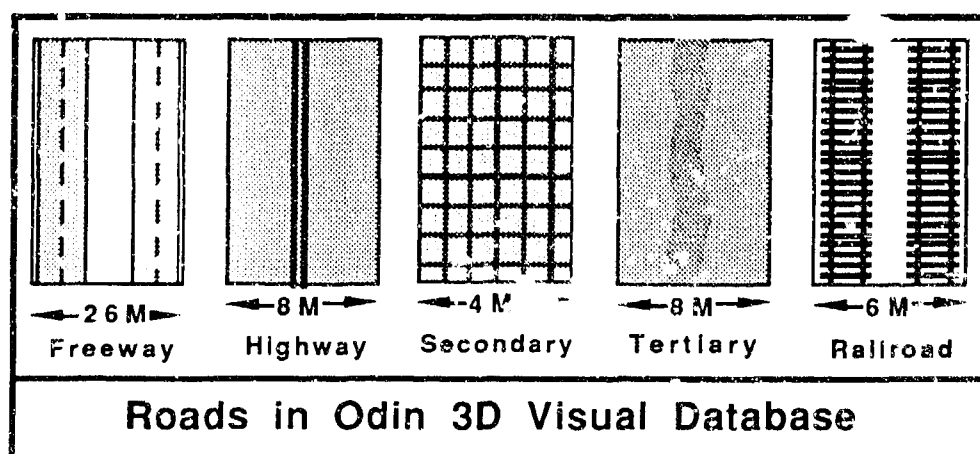
TOP VIEW

Port Facility

500 Meters

(Top View)

These exceptional experiences with TINs for representing coastal features led to development of additional data base construction tools to facilitate TIN placement from feature data

Surface Vegetation. Various texture maps (e.g., grasslands, irrigated croplands) are applied to gridded land polygons to differentiate major types of vegetation as shown in the left-most figure below. Triangulated Irregular Network (TIN) polygons provide great flexibility in depicting irregular boundaries. The second and third figures illustrate the use of TINs to model rotary drip irrigation systems and a portion of the Tigris river valley. This work, performed in the later stages of the project, used the new automated TIN to facilitate modeling higher definition surface features.

TOP VIEWS

1375 Meters
Crop Texture
Rectangular Crops

500 M
Rotary crop texture
Rotary Irrigated Crops

500 M
Foliage Texture
Water Texture
Tree Stamp
River Vegetation

Stamp
(Always rotates to face viewer)
Rotating Tree Stamp

The final figure on the right illustrates the use of a specialized type of model with texture maps to represent vegetation. Trees and bushes are represented using "stamps"--specific texture maps mounted on rotating "billboards". The CIG hardware visualizes these 2D stamps so the vertical plane is always rotated to the viewer. It is a relatively inexpensive mechanism to populate the individual objects, such as trees and bushes, in the three-dimensional world.

Roads, Railroads and Rivers. Roads, railroads and rivers are entered into the S1000 system as networks of linear features with a specified width. From this data, contiguous ribbons of polygonal triangles are projected on the previously defined land surface and distinctive texture maps used to characterize each polygon. Typical road and railway texture maps are depicted below.

| ←26 M→ | ←8 M→ | ←4 M | ←8 M→ | ←6 M→ |
| Freeway | Highway | Secondary | Tertiary | Railroad |

Roads in Odin 3D Visual Database

Textured polygonal "ribbons" are used to model streams and rivers. The texture maps as well as the ribbon can be scaled to achieve a range of visual effects.

Cultural Objects

Much of the visual interest in the 3D data base is derived from the 3D models of cultural objects placed on the terrain surface. Sets of non-standardized three-dimensional models--telephone poles, power lines, water tanks, churches--are starting to emerge as 3D symbols to populate cultural map features in the three-dimensional CIG world. These 3D symbols are analogous to the standardized 2D cartographic symbols used to populate traditional paper maps. These generalized 3D models are termed "Generic Models". CIG hardware stores a single copy of the generic model in memory and instantiates the object at one or many locations as required. In addition to location, scale and orientation can be

varied. Unique objects, termed "Site-Specific Models", are individually modeled as required.

| Typical Generic Models	Typical Site-Specific Models
• Telephone Pole	• Ali Al Salem Airfield Complex
• Oil Pipeline	• Runways
• Oil Processing Installation	• Taxiways
• Power Substation	• Hangers
• High Tension Power Tower	• Major Kuwait City buildings
• Water Tower	• Kuwait Towers
• Berm	• Port Facilities
• Bunker	• Training Barracks

Generic Models. Three-dimensional objects that occur many times are treated as generic models. This means that an object, such as an oil derrick, is described only once and all instances of an oil derrick in the data base are simply references to the generic description adjusted for location, orientation and scale.
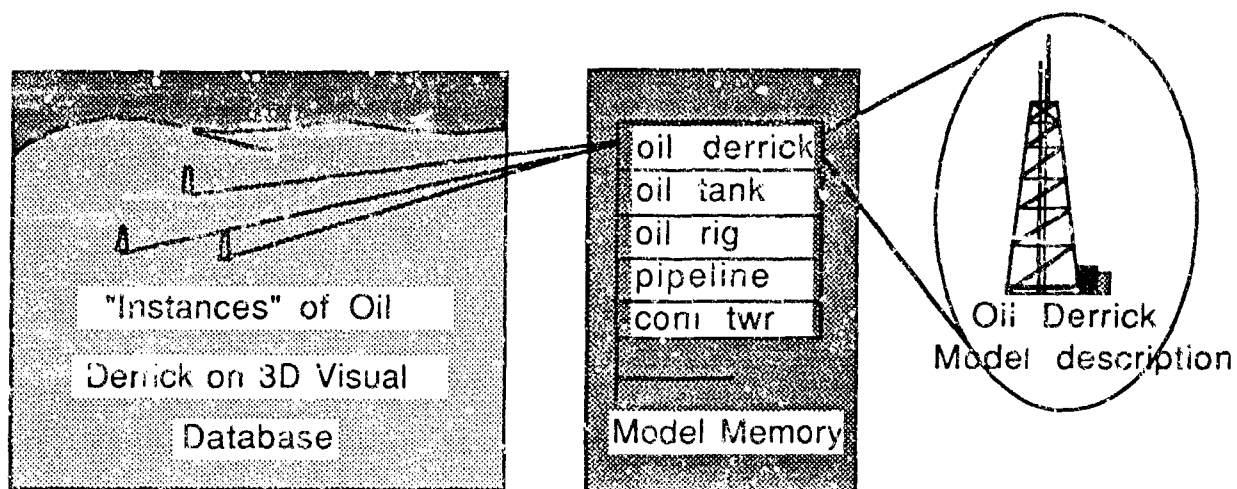
Site-Specific Models. Particularly significant objects can be represented as site-specific models or aggregations of generic and site-specific models. Examples of site-specific models are listed in the above table. In general, capturing site-specific models is one of the most labor-intensive aspects required in data base construction. Rigid system constraints include data storage and the polygonal rendering capacity of the CIG hardware.

Model Bounding Volumes. To support the interaction of dynamic objects (tanks, trucks, artillery shells, etc.) in simulation networking, each static object on the terrain is encased in one or more "bounding volumes", a rectangular volume described by a

footprint and a height. Complex models may require multiple bounding volumes In real-time simulation, collisions between dynamic models and static objects such as oil derricks are computed based on these bounding volumes.

Oil Derrick Bounding Volume
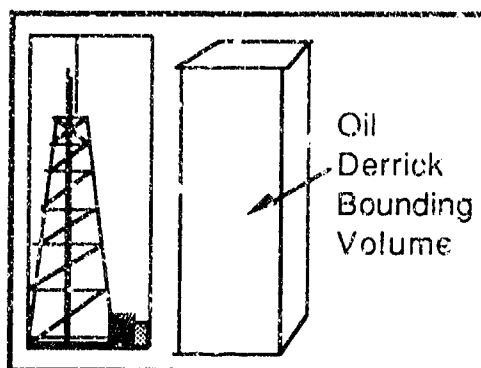
73 EASTING BATTLE SITE

The SAKI terrain data base included the 73 Easting Battle Site, but many features of tactical significance to the battle were not represented. For operational convenience, a tailored 73 Easting terrain data base was created by extracting a 24 km × 44 km region surrounding the battle site from the SAKI TDB. Using information collected from field survey and reconnaissance imagery, the 73 Easting TDB was intensified to incorporate additional detail including tactical fortifications. The sections that follow describe the additional data sources, terrain data base refinements and continuing technical efforts for direct data capture from mapping and reconnaissance imagery.

Additional Data Sources

Revised DMA 1:50,000 Topographic Line Maps were available in February 1991 and used as basemaps for the 73 Easting TDB efforts. In addition, a field team was dispatched to Iraq to physically survey the battle site and gathered valuable field notes as well as extensive terrestrial photography. Additional information was derived from photo interpretation and mensuration of reconnaissance imagery.

Field Survey. On short notice, a field survey team was assembled and dispatched to Saudi Arabia in March 1991. Members of the team are listed below. With the support of the VII Corps Commander, field survey of the 73 Easting Battle Site was conducted by helicopter, from ground vehicles and on foot. Particular attention was paid to line-of-sight in key engagements identified by soldier testimony as well as surveys of barracks, berms, bunkers and other terrain features that figured in the battle.

Team Member	Organization
Colonel Michael Krause (USA)	Center of Military History
Colonel Gary Bloedorn (USA, Ret)	Institute for Defense Analyses
Captain Keith Major (USA)	U.S. Army Aviation Center and School
Major Sandridge (USA)	U.S. Army Armor Center and School
Mr. Michael Barwick	USAETL Terrain Analysis Center

Extensive terrestrial photography was taken. Global Positioning System (GPS) receivers were used extensively in the field for point positioning.

Image Exploitation. To supplement the field work, image analysts in the ETL Terrain Analysis Center used reconnaissance imagery to detail several thousand tank berms and bunkers as well as trenches, logistics sites and barracks buildings. The Light Table Mensuration System (LTMS) was used to derive object dimensions and location for creation and positioning of generic and site specific models with S1000 software tools.

Data Base Refinements

Use of TINs. While the majority of the terrain surface was derived directly from DMA DTED Level data and transformed into a standard SIMNET 125 meter grid, key ridges identified in the field were detailed in the 73 Easting TDB using Triangulated Irregular Networks (TINs). Based on field survey, formlines recorded on the 1:50,000 base map were interactively digitized using S1000 TIN software to generate microterrain. Major defensive trenches were also modelled using microterrain.

Generic Models. New generic 3D models were created for defensive tank berms and associated crew bunkers. Tactically significant instances of the berm and bunker models were placed on the terrain surface based on data derived from field survey, ground photography or extracted from imagery using the LTMS.

Site-Specific Models. Three-dimensional models were created for individual barracks buildings and logistics sites. Here again, data derived from a combination of site survey, terrestrial photography and reconnaissance imagery provided the necessary information to construct a set of site-specific 3D models of these Iraqi facilities.

Continuing Efforts

Traditional data base construction efforts for SIMNET and other CIG training systems have relied on interactive digitization of feature data from paper maps and charts. Issues of map currency or sufficiency, that have had little impact on training applications, are critical in operational applications as seen here. Use of orthographic image maps as pioneered in the SAKI effort represents a "brute force" approach to transform current imagery into two-dimensional map products that can be used with existing data base construction tools. Timeliness, flexibility and responsiveness are enhanced eliminating the intermediate products and implementing capabilities to derive the data directly from mapping and reconnaissance imagery. While film-based instruments such as the LTMS[11] provide tools for extracting spatial data from hardcopy imagery, continuing efforts at the Topographic Engineering Center and elsewhere focus on the extraction of feature data directly from digital mapping and reconnaissance imagery using "softcopy" image exploitation technology. These efforts at TEC build on digital mapping and image understanding technology as represented by the following three systems.

Image Digitizing System. The Image Digitizing System (IDS) is a state-of-the-art flatbed scanner designed to convert aerial photography into digital image data with high geometric and photometric accuracy. The scanner accommodates panchromatic or color film transparencies in sizes up to 23 cm × 23 cm. Using a push-broom CCD linear array for high-speed digitization, the IDS features effective apertures as small as 7.5 micrometers. While some of our source materials (i.e., Landsat Thematic Mapper or SPOT imagery) are distributed directly in digital data, large quantities of mapping and aerial photography are recorded on high-resolution film. The IDS provide a reasonably fast capability to transform film-based imagery into digital data for interactive and automated processing on softcopy systems. The IDS was developed for TEC by Intergraph and Carl Zeiss; it is now available as a commercial product.

Digital Stereo Photogrammetric Workstation. The Digital Stereo Photogrammetric Workstation (DSPW) integrates an automatic system to extract elevation data from stereo imagery with an interactive system to edit extracted data and to function as a three dimensional digitizer. The DSPW extends technology developed under DMA's Modernization Program onto modern engineering workstations such as the SUN 4. Current efforts at TEC include developing direct interfaces to the SIMNET S1000

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[11] Also stereo analytical plotters such as DMA's Feature Extraction (FE) System.

environment for custom generation of high-resolution digital elevation models, point, linear and areal feature data and site-specific wireframe models. General Dynamics (GD) developed the DSPW for TEC; a commercial version is anticipated shortly.

SRI Cartographic Modeling Environment. The DARPA Image Understanding Program has addressed a broad spectrum of basic research issues associated with computer vision, as well as applications in such problem domains as image compression, autonomous navigation and digital mapping. The Cartographic Modeling Environment (CME) developed at SRI International has been particularly influential in digital mapping developments. Typical CME capabilities include interactive capture of point, linear and area features as well as wireframe building models from oblique, monoscopic imagery. Related efforts include techniques for Image Perspective Transformation--non-real-time photo-texturing of imagery onto terrain surface and building models from arbitrary viewpoints to create static scenes and continuous "fly-throughs." The research capabilities pioneered in CME are now being embodied in a Unix-based RADIUS Common Development Environment (RCME) as a key component of the interagency Research in Image Understanding Systems (RADIUS) Program.

LESSONS LEARNED

Terrain data base construction tools and procedures, previously developed to support training applications over gaming areas typically 50 km × 100 km or less, had to be enhanced significantly to meet the needs of modeling the Kuwait Theater of Operations.

- Standard Digital Terrain Elevation Data (DTED Level 1), previously compiled and distributed by DMA, was critical for rapid generation of a prototype terrain data base of eastern Kuwait and then SAKI terrain data base. A project of this nature is not feasible without suitable digital elevation data. Assessment of the DTED to understand its source and accuracy was essential to intelligent utilization of the product.

- No single set of maps or other data source provided adequate coverage, resolution and timeliness to derive feature data to support ground forces. Diverse source materials had to be assessed and exploited selectively.

- Generation and exploitation of SPOT and Landsat TM Image Maps was critical for data base development with existing data base construction tools.

- Effective integration of multiple sources with numerous datums, ellipsoids and projections required rigorous attention to coordinate conversions and transformations within a geodetic frame of reference.

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- Building the much larger terrain data base did not scale linearly based on past efforts. In addition to increased requirements for data capture, storage and computation, significant software extension was needed to support the larger data base size and maintain a rigorous geodetic frame of reference.

- Continuing development is needed to support direct data capture from digital imagery to maximize responsiveness, flexibility and accuracy. For each collection system, a rigorous sensor model and recovery of image acquisition parameters are required to support the map-to-image and image-to-map correspondence essential to update and maintain a digital map data base. In-house efforts at TEC focus on use of the Image Digitizing System and the Digital Stereo Photogrammetric Workstation while complementary activities are being pursued under the DARPA-led RADIUS Program.

ACKNOWLEDGMENTS

--73 EASTING--

DATA COLLECTION METHODOLOGY

Colonel Gary Bloedorn, USA (Ret'd)

Institute for Defense Analyses

COLONEL GARY BLOEDORN: DATA COLLECTION METHODOLOGY

I would like to introduce my right arm who has also worked on this from the very first day, part of his creative genius is reflected on a lot of the novel solutions that have found their way into SIMNET that saved us time, money and effort and yet really addressed the task. Mr. James McDonough, President of Illusion Engineering Incorporated in Westlake Village in California, has been one of our chief analysts. He and his staff have been in direct support of the program and Jim will help me explain what we are about this morning.

As George put the ground, the dirt, into the simulation it was our job to define all of the dynamic objects in the battle into the simulation. Let me make one observation, before I get into how we did that. I encourage your questions as we present it. Don't let it slip by, ask the question and see if we can answer it as we go. But the observation is we're dealing now not so much in simulation as we are in a reenactment of an actual event. One of the first questions that was asked, by this gentleman up front here, who focused on it very quickly, was, given all of the dynamic interactions, second and third order interactions, in a battle, how do you get all of that data? Now we all know that reality is a very difficult concept to define. When we talk about the terrain, and we talk about polygons and data, we've got a solid mathematical formula, one that can convert reality into a representation. But when we go into a man's mind, he processes information differently and he expresses what he experiences, yet again, in a different way. We have a very distinguished historian out in front of me here, Col (Retired) Trevor Dupuy. He and his father are famous in the business. And they have experienced this I'm sure in space. And you know exactly what I'm talking about. So we'll try to tell you how we went about this task.

Because we had a very unique task, I could not simply write about it and leverage a person's imagination to fill in the blanks. We had to have excruciating detailed data to portray and when you talk to the participants of a battle in a military organization you are forced into a hierarchical structure. The entire chain of command wants to brief you. You're putting them down in history and they will tell you in excruciating detail where the phase lines went and when the movement schedules were and they will tell you absolutely nothing at all about what the tanks did and the units did and the detail you need to make the simulation. And yet, all of that is absolutely necessary from the historical perspective. So we'll try to tell you how we parsed out our effort, how we took care of it. Col. Krause was the head of our team and it was his responsibility to field the questions from the corps

commander, regimental commander and the operations officer, to get the big picture. He did it so well. My job was to try to document the battlefield. So the way we're going to do it today with your cooperation and patience, is I'll give you the phase that we're in, and I'll show you the actual products, that came out of that, exemplars, sketches, photo logs, photos of the battlefield, testimonies, and then I'll tell you how we used that data, how we aggregated it, collated it, turned it over to my brains (McDonough) over here, and how we analyzed it. His charming staff, these two young ladies up front, were really driving that effort. We found inconsistencies and the validated events. We'll show you how we went back to the soldiers and we'll take you from what they told us in their sketches, testimony and our photos and we'll go back into the data base to show you what it looks like now in the simulation. We'll do this for one purpose...so you'll know what to believe and so that you can ask the questions, give us your suggestions and tell us if you think that the data is solid, or it needs to be further developed or come up with some ideas of your own in the future on how to use this technology to reenact reality. So with that in mind let's take the first slide please.

SLIDE 1: BATTLE OF 73 EASTING DEVELOPMENT

- CONCEPT DEVELOPMENT: 26 March-2 April
- INITIAL DATA DEVELOPMENT: 9-18 April
- DATA ANALYSIS: 19 April-15 August
- FUNCTIONAL DESCRIPTION: 19 July-3 August
- Simulation Development: 10 July thru Present

In SIMNET, it's almost an article of faith that before we start out, it's just like the Army, we sit down with the program managers, in this case Major Wargo and Colonel Thorpe, and we put together a concept development. Jack was given the job, we talked about it on about the 26th of March, and we started on the 24th putting out a concept paper on the 26th. We follow that with our initial development of the data and you'll see the times that we did that we were in country and how we did it. Our data analysis culminates in the issuance of a functional description.

The functional description describes the attributes of a simulation, or in this case, the reenactment of the battle in all of its attributes; what should it do and how it should do it. We then turn it over to the software engineers, and the people who build the simulation. Notice that these areas overlap, so that as we accomplish one phase we start feeding data to the other phase so we get a parallel development going. The concept development serves those functions. It gets us all on the same sheet of music, establishes a requirement, makes sure that the sponsor of the program, the program managers, understand where we're going, what we think we're going to build, it defines the deliverables and it does that before we spend any money or effort. It forms the development team by assigning responsibilities to people the government has decided will do the job. We define those deliverables and we associate them with that development team. So everybody knows what their job is before we start out. It provides for control of quality and I'll discuss with you in this conference how we control quality. How we check that we have defined as a deliverable and what we have defined by the data, as an event...a happening, we know that it shows up in the simulation. And it establishes the schedule...without that schedule we could not have gotten here. If there are any questions on any point, interrupt.

Let's talk about the initial data development. This is a quick and hurried effort to get into the country and we ended up on a Mac flight that took us to Bahrain instead of Riyadh. Col. Krause and I were hitchhiking with the Navy through the desert with our team and they took us to Riyadh and they left our baggage in Bahrain. But the single most critical part of our entire effort was for us to get in country while we still owned the battlefield in Southern Iraq. And I'll try to make that plain, why as hard data, incontrovertible data, this was absolutely necessary. We'll discuss these issues in that following sequence.

SLIDE 2: CONCEPT DEVELOPMENT 26 MARCH-2 APRIL

- Establish the Requirement
- Define Deliverables
- Form Development Team
- Provide Quality Control
- Establish Development Schedule

The data elements that we needed, were the ones that you would expect, who, what, where, and when. And we broke those down as, what were the events in the battle of 73 Easting. And as you already know when we say events we mean vehicle by vehicle, crew by crew, fire mission by fire mission on both sides. Where did they occur, what time did they happen and in what sequence. Often when you're trying to get information out from people's minds they don't know what time it happened but they know in what sequence it occurred. They can tell you I fired before he did, or he fired, missed and then I shot. So the sequence, for us, became one of the most critical data elements in determining those dynamics of the battlefield that we are trying to portray.

SLIDE 3: INITIAL DATA DEVELOPMENT: 9-18 APRIL

- **Definition of Data Requirements**

- **In-Country Army/DARPA Team Actions**

- **Initial Analysis of Data**

- **In-Country Follow-on Actions**

Because this is a military operation, we found a lot of sources, and you can see them up here, the radio net recordings in the 2nd Cavalry became one of the things that was a boon to us. You heard part of it here, we are still subjecting it to noise filtering but by putting that on a piece of paper and plotting out the grids, the coordinates, knowing the CEOIs, we could plot out sequence in time and relate that to location with a great deal of specificity. One of the other things that we got was the global positioning system (GPS) that the troops relied on. It was so important that they never made a report without referring to it. What this did, because only the lieutenants, captains and squadron commanders had GPS's out there, it sort of enforced radio discipline. As we go over their logs we see that the guys with the GPS's are the guys doing the talking. We have more discipline than you would normally expect. By putting this together with eyewitness testimony, and physical inspection of the battlefield, we were able to get our first real look at what went on out here.

Q: Did it prove useful to the process to record the communication?

A: (BLOEDORN) We were lucky that these soldiers had a sense of history that they were going to do the job quickly and on their own initiative and in Echo, what was really unique, they put it in the fire support team vehicle, in Iron they put it in the tactical operations center but in the fire support team vehicle you could actually hear the FIST processing his fire requests. Those are very specific, those fire requests. He's got a laser designator, he's got precise coordinates on the enemy and he's got precise coordinates where he is. When we got that piece of information....

A: (McDONOUGH) The other thing that made that very useful was the fact that in that FIST vehicle there were four radio nets going simultaneously. All four of them carry information that was of interest to us. So although it makes it very difficult to hear for a naive listener, if you pay attention, and listen 47,000 times you can start picking out the key data elements as to when a certain fire mission was fired or where a certain element was.

Q: Any other units do this?

A: (BLOEDORN) I don't know. The only other units that we interviewed were 2nd Cavalry units.

Q: I think a number of other units did the same. There are also the other kind of spinoffs of coordinates where in one case in Ghost PFC Kirk had a hand held recording that would spin into that and say the time is now and we're doing this...it's total chaos and you get some of the human dimension of that on that kind of a hand held, doing it just for himself, really recording it for his mother...

A: (BLOEDORN) Plus of course the aviation units record through their cameras and things of that nature.

Q: Is anything being done to get those tapes home?

A: (BLOEDORN) We have them.

Q: No I mean the other units.

A: (BLOEDORN) We cannot talk beyond the 2nd Cavalry and the units that we interviewed. Mike did the same thing with the other units however...

A: (KRAUSE) I think they'll come down to us eventually. We did similar things in other wars and saved them but the transcription process is not quick.

Unit logs...the artillery of course feeding off TACFIRE and their logs, at what they fired, how many rounds they fired, what their bomb damage assessment was, we accessed very early on. To orchestrate the fire support, we know the type of weapon, we know the information from the counterfire radar systems, counter battery missions that were fired, and during this conference I just received, hand delivered to me, from an officer from the 2nd Cavalry, the log of the S3 of the 2nd Squadron. It has somehow gotten displaced and we had persisted and persisted and we now have that log which we will now add into our analysis.

Most interesting, the interviews. May I have the first enveloped slide please...

ENVELOPE SLIDE 1: Original Sketch of E/2/2 ACR Battle of 73 Easting

We sat down with each unit commander in the desert and these were drawn on the side of a tent with a jeep headlight. We gave all the sergeants a form to fill out about who they were, who was on their crew, what weapons systems worked, what didn't work, where were they. Each vehicle commander and lieutenant stepped up to the map and drew in his vehicle over time and this is the actual map by the way, this is a copy of the map they used, a plain gridded system that the regiment drew on butcher chart paper, to report locations and record the battlefield. The graphics you see are the graphics of the regiment and the squadrons. And then the soldiers sketched in for us and talked into a tape recorder as they drew in their sketches and told us where they were. A couple of interesting things that I'd like to point out.

The village was initially plotted down here. The soldier recollections of where that village was during the heat of combat, as large as it is and as prominently as it figures in the battle, even though they were equipped with GPS they located that village 800 meters southeast of its actual location. And I can't tell you the times, the problems that has caused us in reconstructing this battle. George Lukes, when his reconnaissance imagery finally came in, we had one Lieutenant out of all three troops who said it's not there, here's where the village is. And he said it every time we got ahold of him and all the captains were saying shut up and sit down lieutenant that's not where the village is. The lieutenant was right, and our reconnaissance imagery showed it. But that's the cross checking, and I'll get into that.

Notice here they tell us where they stopped, they fired at OP- their routes through an organization, everything Iron Troop did was sketched in great detail in an interview with Major Mike Sandidge of the Army's Armor School. Mike was the chief of the armored
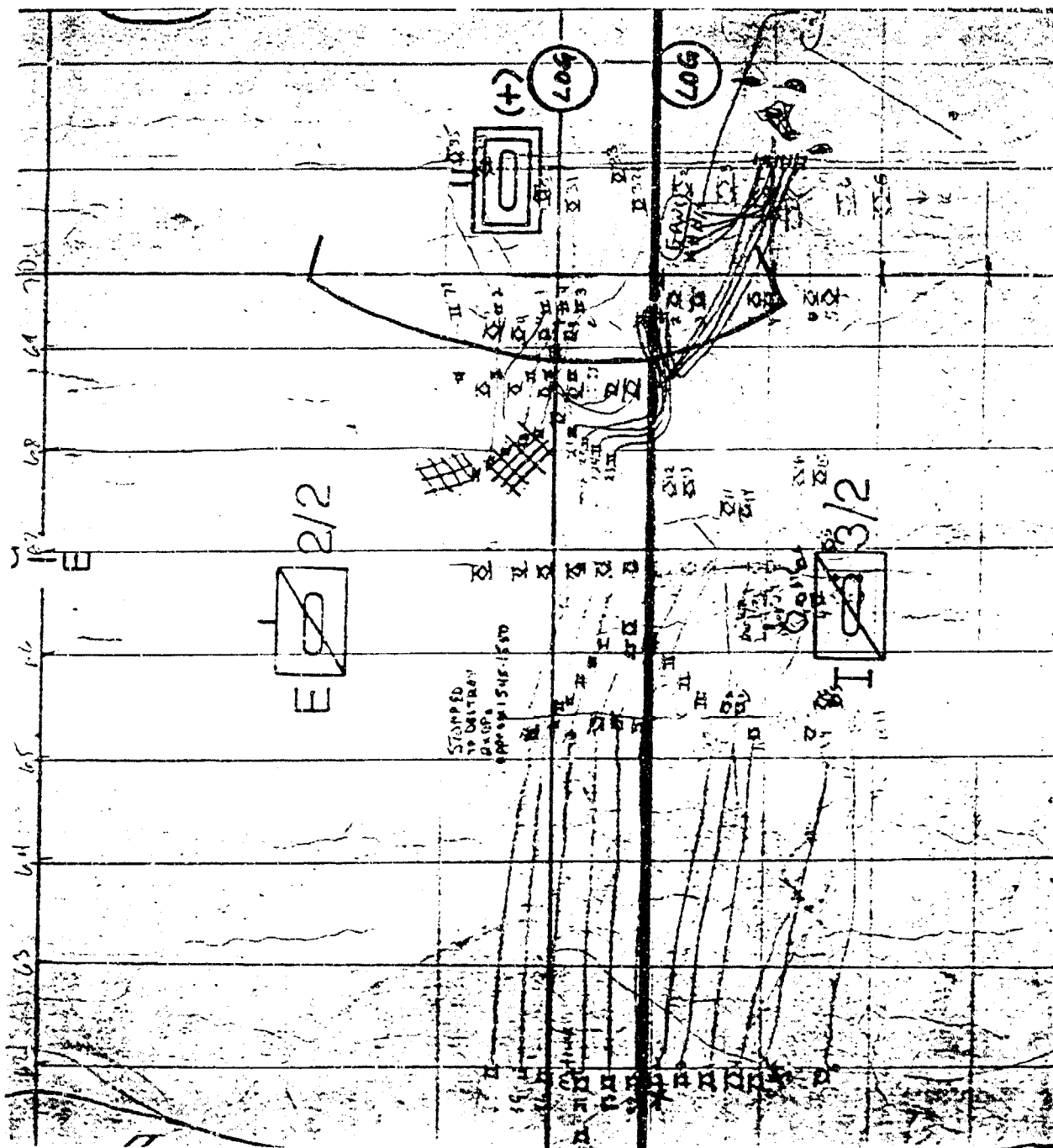
Original Sketch of E/2/2 ACR Battle of 73 Easting
(Envelope Sketch #1)

cavalry branch of the Command & Staff Department of the Armor School. He was present in the desert with us, interviewing these soldiers, I wanted a uniformed officer to talk all the subjects with them. You can see that this was our initial bit of information. This was by the way, free association, there was no structure to it, the chain of command was present, they argued and talked among themselves, they agreed among themselves, and they agreed that that was ground truth. Now you can see that sketch just gets us onto the battlefield. We did it the night before we visited the battlefields, so we would have a sense of the scheme of maneuver while we walked the tracks and walked through the battlefield the next day. We did this for each troop and each vehicle in the battle. At this time, the only information we had on the enemy was shown by the graphics that you see out there of a tank battalion reinforce sign and two log sites. Any questions on that at all?

Next slide, please.

SLIDE 4: DATA ELEMENTS

- **Events**
- **Locations**
- **Time**
- **Sequence**

We then went through the following events.

SLIDE 5: EVENTS

- **Radio Net Recordings**
- **Unit Logs**
- **Fire Direction Logs**
- **Interviews**

Once we had some documents in our hands, we had to go back and look again to get some timeframing when the battle went and we used this as records.

SI<ide> 6: TIME

- **Fire Direction Logs**
- **Unit Logs**
- **Radio Net Recordings**
- **Cross-referenced Interviews**
- **Reconnaissance Imagery Data**

Then we went out to the battlefield. Next slide.

ENVELOPE SLIDE 2: Photo Slide LOG by Maj Sandridge.

Here's an example of a log slide made by Major Sandridge following the Iron Troop battle and he talks about the roll of film, frame number, we had the GPS with us, we took the coordinate, the magnetic azimuth the lens was pointed, the distance to what we were photographing, and then the position, why did we do it. It was the view of I-66 front first enemy contact with tanks and the testimony that they said was at 1620 hours. So now we started building a data trail. We photographed what they had drawn the night before in sketches. You can see going down this list that we recorded each photograph, zoom, what happened, and we did this with the unit commander on the scene as he walked our photographer and our interviewer, in this case Major Sandridge, right through the battle area. We started now making another closure on ground troop. If we go back to the previous slide, here in this kind of data, we also had, because we had gotten hold of it, the regiment did a survey after the battle, they went through and surveyed each vehicle that the Iraqi Republican Guard left on the battle. That's part of the unit logs that we have, and their surveys. I could then compare the survey sheet with each hull that we photographed and we looked at. We got the angle of the hull, the angle of the berm, their estimate of what killed that target, whether it was a SABOT, a TOW round, an air kill, what have you. We had with us at that time all of the regimental survey sheets. Now we could go through, photograph the firing positions, and the enemy. Part of the photography, we actually went to firing position and we could see spent 25mm brass. We could see spent tow wires, laying in firing positions. Now of course we couldn't get to all of them, but we recorded those that there was physical evidence on the battlefield. We located the exact spot with the GPS of Ghost 16 which was destroyed by an Iraqi BMP and we actually inspected that hull

73 EASTING STILL PHOTOGRAPH DOCUMENTATION WORKSHEET

PHOTOGRAPHER'S NAME: Sandridge
Roll 2
SHEET SEQUENCE NUMBER: 1

FRAME NUMBER	CAMERA LOCATION 8 DIGIT	MAG AZ	OBJECT PHOTOGRAPHER RG/DISTANCE	PHOTOGRAPHER DESCRIPTION	COORDINATION (Tie to Reconn/Inserting Cue)
1	630992	65°	1400 m	Posit - View I66 front / Eu Contact w Tanks	1620 hrs
2	630992	360°	800 m	View of Tank I66	"
3	630992	65°	1400 m	Zoom view of 1	"
4	630992	65°	1400 m	Zoom View of 1	"
5	633951	271°	105°-15'	OP Destroyed By I Before / Act 1/2	1610 hrs - 1615 hrs
6	694010	271°	1400	Rev Slope E Troop / Enemy View	1607 hrs
7	694010	315°	1660	2 Enid Engs by E Co / Note Th Beam on Rear Side	1607
8		15°	5.9 m	Tank McMaster Slot / View from Front - Note Rear GAP from SABOT	1607
9	"	20°	" / Results	

Photo Slide Log by MAJ Sandridge
(Envelope Sketch #2)

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and the remains of that vehicle still on the battlefield area. We followed the vehicle tracks with the unit commanders as they described the battle. With the interviews and photos we established vehicle and fortification locations. Next slide.

SLIDE 7: LOCATIONS

- Destroyed Vehicles
- Bunkers/Revettments
- Damaged Buildings
- Firing Positions
- Bomb Craters
- Interviews
- Photos
- Reconnaissance Imagery Data

Are there any questions of our battlefield activities? What we did?

Q: Did you go back and reinterview the crew?

A: (BLOEDORN) Yes, sir, we did and there was one intervening step. And that's my next slide.

ENVELOPE SLIDE 3: 1:50,000 MAP WITH INITIAL PLOT OF IRAQI VEHICLE POSITIONS.

The team went back to King Khalid Military City after we got off the battlefield and we took one of the 1:50,000 scale maps that they didn't use in the desert. We plotted each position in time by the sketch they had drawn and the firing positions we had found and we plotted each target or each destroyed Iraqi vehicle and we assigned it a code number for automation when we got back to the United States. We established the initial positions where our vehicles were, where the enemy was, and approximate times that they said they were there. This gave us a bit of heartburn. We saw immediately, that there were inconsistencies in the data that people identified targets that they fired at that were not within their fan, or it was not line of sight when we got on the battle. All of the things that you would expect the historian to run into. So Col. Mike Krause and I sat down and scratched our head and said "Hey, we've got a problem." The troops are gone. When we were on the battlefield they were moving out to El Jabail, getting ready to go back to the
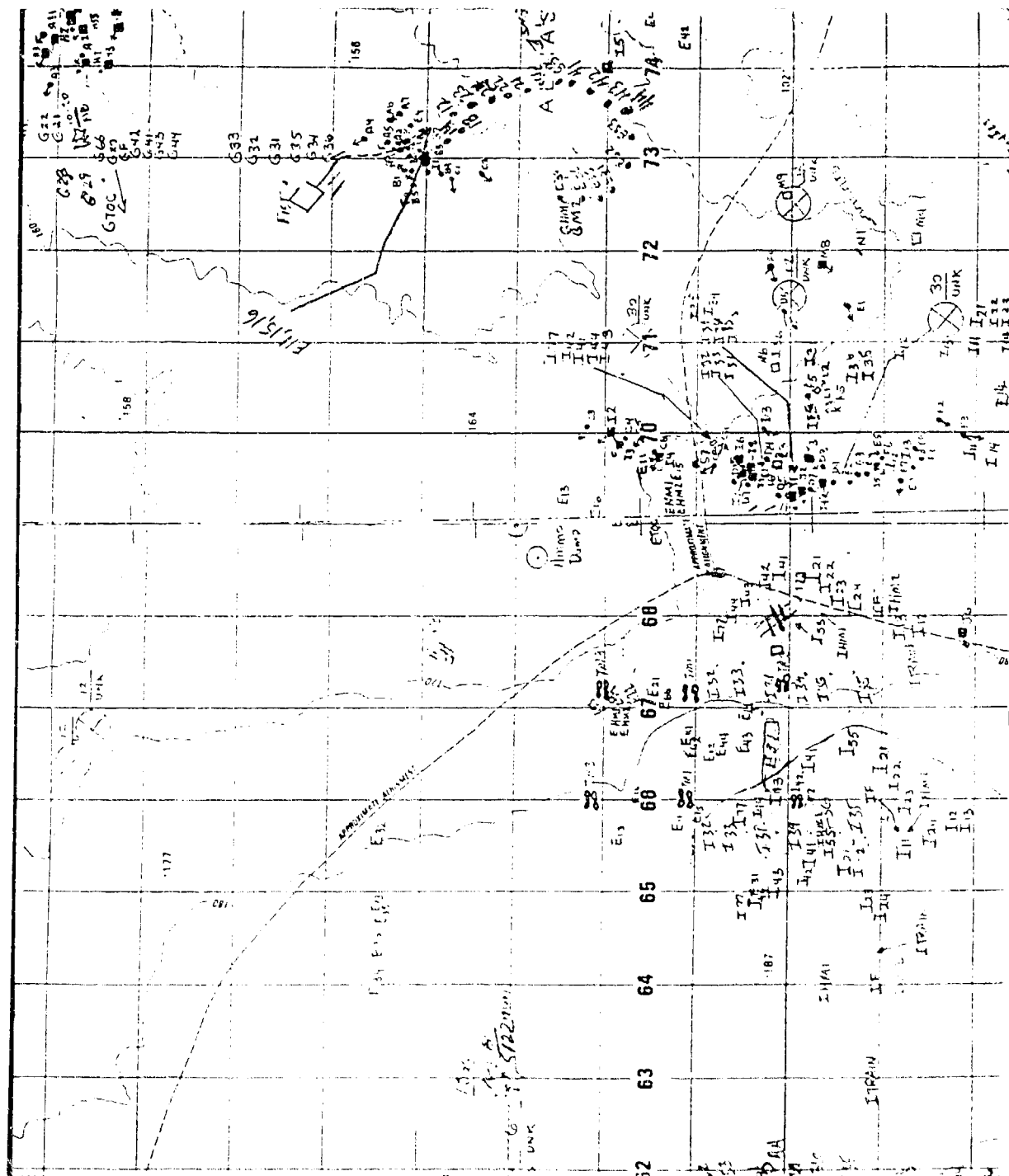
1:50,000 Map With Initial Plot of Iraqi Vehicle Positions
(Envelope Sketch #3)

United States. We had questions that we needed to get answered before we got back to CONUS to get this started. So we made a calculated risk and we got into our little vehicle and we drove down to El Jabail, talked to the regiment and said "We understand you're washing tanks, you're putting them on the boat but we've now got a structured interview. We've got specific questions of specific individuals that we need answered and would you help us?" And Colonel Holder said "You bet." Here's a recreation center, you guys can sleep there on the pool table and as the soldiers come off the wash rack we'll bring their commanders in, their unit guys in, and we'll start to look at it. By the way, Colonel Holder wanted a copy of this map, he really liked it. It showed him the first detailed look of where each one of his vehicles were over time on the battlefield, understanding all the limitations that were in the data at that time. Any questions on our followthrough? Next slide.

SLIDE 8: SEQUENCE

- Logs
- Cross-referenced Interviews
- Diagramed Platoon Battles
- Subsequent Interviews

We were able to determine the sequence of the events along the time line from the sources shown on this slide.

Down in El Jabail we took those diagram platoon battles and we did subsequent interviews. Next Slide.

SLIDE 9: IN-COUNTRY FOLLOW-ON ACTIONS

- Structured Interview w/Troops
- Analyze Data From Interviews

I'm going to give you some example of what they did for us in asking questions when we got down to El Jabail. Next envelope slide.
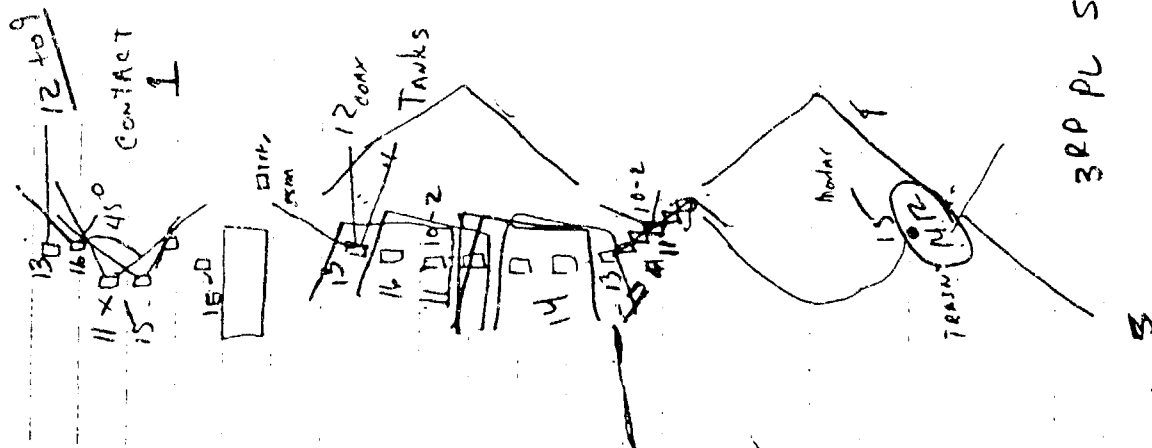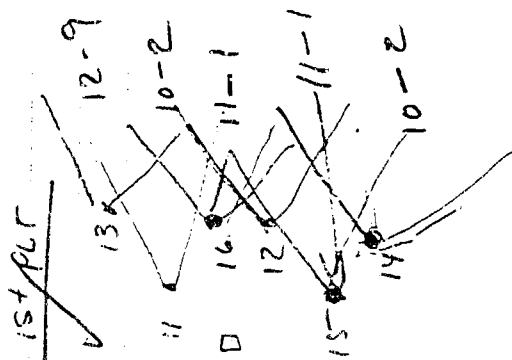
ENVELOPE SLIDE 4: UNIT Battle Drills

This is a sketch of a unit, where their mortars were, what their sectors of fire were, where their first contact was, where they moved. It shows what their battle drills were, where their distribution of fire was, because we found targets that we could not at that time, pair to the specific firing vehicle, we just didn't have enough information. What we wanted to do was get the soldiers to walk through where we had the survey sheets, and we had the time sequence testimony that conflicted from the three different troops and Colonel Krause is on my tape doing some very specific questioning about time sequence between Ghost, Echo and Iron. We wanted to match the survey sheets, which showed the angle of incidence of the round, where it came from and what type of round, with the sector responsible for those vehicles to get our first pass through for those things that they hadn't clearly identified--I shot from this location and killed that tank. This is one example of the kind of crude data that we started off with in the simulation. Any questions? Next slide.

SLIDE 10: IN-COUNTRY ARMY/DARPA TEAM ACTIONS

- Briefings/Document Review

- Interviews to Vehicle Commander Level

- Air & Ground Recon of 73 Easting Battle Area

- Collected Photo, Survey, and Radio Net data

- Photographed Key terrain w/ETL

- Reviewed Corps BRC Data

Armed with all of this good information, we went and talked to the VII corps staff and found that they had some really neat stuff. VII Corps had what was known as a Battle Reconstruction Center. The center's sole purpose in life was to collect every bit of

II-40

Unit Battle Drills
(Envelope Sketch #4)

--73 EASTING--

DATA REDUCTION AND ANALYSIS

Major James McDonough, USA (Ret'd)

Illusion Engineering, Inc.

JAMES McDONOUGH

Gary came back with a sea bag full of stuff. Multimedia, I believe, is the high tech phrase. Our job was to try to reference this stuff and find out what we had, put it in some sort of a usable medium so that we could manipulate the data and then try to develop what we believe was our best first order approximation of what actually happened on a vehicle by vehicle basis throughout the battle. The job was done, keeping in mind that the ultimate output of the job was going to have to be something that would show on one of these real time motion things which meant that it would have to be data gathered at a level of specificity that was not traditionally picked up for these things. Such things as where was this turret oriented, where was this hull oriented, how many meters did he move at what speed, was he moving and even though the individuals involved, in some cases, couldn't tell you that, and there was nothing in the raw data that would tell you, you knew that you ultimately had to get to that level of detail so the organization was done with an eye toward doing that. The first thing was movement, we knew we were going to have to get where everybody was all the time and their orientations. The second thing was target fire pairings, who shot, when they shot, what they shot at, what the result of the shooting was, what type of munitions they shot, how many rounds they shot. Indirect fire missions were a little easier, they just had to be the time it was fired, the number of rounds, where they landed, and then the locations of things that as George Lukes pointed out earlier were not immediately available on the terrain data bases that we had, the maps and even the overlays in many cases. Weather and visibility, we had a number of sources that Gary brought back that we could check that from.

SLIDE 11: INITIAL ANALYSIS OF DATA

- Vehicle Actions & Positions
- Firer-Target pairings
- Indirect Fire Missions
- Minefields
- Field Fortifications
- Weather/Visibility Envelopes

Next slide:

SLIDE 12: DATA ANALYSIS 19 APRIL-15 AUGUST

- Produce Tape Transcripts To Determine
- Aggregate Data To Create First Look At Battle
- Work w/ETL to Refine Terrain Database
- Initial Simulation: 28 May – 5 August

First thing we had to do was take all of the audio tapes we had, and there were several. We had as Gary pointed out, tapes that were made during the action itself, and then the tapes that Gary had made when interviewing the troops (Gary and Mike Sandridge and their assistants), we had tapes that were made at El Jabail afterwards and those had to be transcribed.

Next slide:

SLIDE 13: PRODUCE TAPE TRANSCRIPTS TO DETERMINE

- Vehicle Positions & Routes
- Dismounted Actions
- Firer-target Pairings
- Indirect Fire Missions
- Field Fortification Locations

We then had to make a series of charts to aggregate that data in terms o. reating this first look. We did that in two media; the first was in graphic media, we put up maps on the wall and built overlays on a vehicle by vehicle basis. Then we did a timeline, a Gantt chart type of timeline, where we had the time going across one axis and events going down the other axis.

Next slide:

SLIDE 14: AGGREGATE DATA TO CREATE FIRST LOOK AT BATTLE

- **Time Lines**
- **Firer-Target Pairings**
- **Indirect Fire Missions & Effects**
- **Define Ancillary Operations**

Once we were done producing the video tape transcripts, then we screened every reference everybody had, the vehicle positions and routes, every reference they had to the various actions, target fire pairing, and all of these other elements which we were searching for. Invariably we found conflicts and in some cases, large gaps in our information. But that was our first try.

We had two media by which we laid things out. Primarily we depended on graphic overlays on maps to get a gestalt of what was going on and we also used a timeline.

Next slide:

SLIDE 15: DEFINE ANCILLARY OPERATIONS

- **Actions at Contact Points**
- **Process EPW, Minefields, MEDEVAC**
- **Reorganization & Consolidation**

There were some key operations we had to simulate and they often overlapped a number of people. For the most part they were not instantaneous or specific to one exact place or time. We tried to identify those operations and they fell into categories generally as you see up there. Then we searched all of the data we had, all the transcripts and all the log data, to come up with a definition of these ancillary operations.

Next slide.

SLIDE 16: WORK WITH ETL TO REFINE TERRAIN DATA BASE

- Access & Use Reconnaissance Image Data
- Hand Tool Key Terrain For LOS
- Refine Field Fortification Data

We started a long correspondence by fax, telephone and what have you with George Lukes and his folks to: (a) ask them a lot of questions about the terrain, and (b) tell them things we were learning that we thought might be useful for them in developing their terrain data bases.

BLOEDORN: This is where we solve the location of the village, by accessing reconnaissance information. We got a hard point located, confirmed which guy was telling us the truth in the interview tapes, specific locations of certain areas. One thing that you'll see in the data base that is supported by reconnaissance imagery, counter attacks in Ghost came through the 3rd Armored Division sector before 3rd Armor got up there...were outside the regimental zone and were not recorded in their survey. The corps commander's helicopter pilot, would not let me land in that area, because there were unexploded munitions. So I had to fly over it, detail it, and photograph it from the air. Those vehicles showed up no where else, except in the overhead in reconnaissance. So those kinds of things had to get started right then. We knew they had claimed shooting things that didn't show up in other databases. So we had to start chasing those targets down.

McDONOUGH: I think it was also useful at this stage because we were starting to realize what information on the terrain was going to be of tactical significance. We were able to help direct George's folks with their research as well. It was a sort of a closed loop type process, where we would ask them questions and also layout information requirements that we knew would appear on the final data base. I think it helped focus all of our work because they would remind us what ground truth was and we would remind them where ground truth wasn't in sufficient detail right now to do the job.

BLOEDORN: And in certain areas only ground truth was in our possession where we would get these finite sightlines and very gradual rising and falling of the terrain that had tremendous tactical significance but didn't show up on other sources but we had walked the battlefield and in our logs had photographed those sightlines because the vehicle commanders told us I had to move to this position before I could see the enemy. So we could go into the data base with George's people, talk with George's people at ETL and show that line of sight has to be from here to here, it isn't back here. That kind of detail is what started as a result of the initial analysis and continued right on through today. We are still working to refine this.

Next slide.

SLIDE 17: INITIAL SIMULATION: 28 MAY-5 AUGUST

- **Use Army SIMNET to Create 3D View of the Battle**
- **Use 3D View to Validate Ground Truth**

McDONOUGH: This was a real revelation to me when we did this. Once we had done the best paper and pencil knuckle drill we could and believed that we had as accurate a representation in static form of what this battle was, we took ourselves to the SIMNET site at Fort Knox and then to a similar suite of equipment at BBN labs in Cambridge. We said, let's take the existing SIMNET and later ODIN utilities and use them to fight a battle, control these semiautomated forces that exist already in SIMNET, so that the battle comes out exactly like this. That was a nontrivial undertaking as the folks at BBN will attest, because the tools that we were using were not designed for this job. The tools we were using were designed to fight in free play exercises so the semiautomated forces had their own logic and would decide who to shoot at and who not to shoot at. In our case, we wanted them to shoot at a specific guy at a specific time. The man/machine interface tools were designed as a training system so that nobody could have a God's eye view of the world and nobody could cheat. We wanted to cheat like mad. It was an interesting experience, and it worked. By the end of a couple of days we had what we believed was a pretty good simulation of the battle as we understood it at that time. The most significant thing I learned doing this simulation in the process of developing the knowledge of the battle, it was a great quality control.

BLOEDORN: He's right, it was, but there are two things that you should know. One, we stumbled into doing this because we did not get adequate time on the ground with the soldiers. I wanted a day with each troop with all of the NCOs for each sector walking through step by step, and we couldn't do that because they were heading for the port. All I got was a commander. Second, we couldn't walk through all of the target areas due to unexploded munitions, we could only drive through it with reconnaissance vehicles, so we didn't get everything. So we decided we would put it on ETL's training data base, put them in a SIMNET vehicle and take them back to Iraq, in simulation. Secondly, we didn't have, except for about 10 percent of the vehicle fire or target pairings, data that we were confident in. Because SIMNET has semi-intelligent algorithms to acquire and engage targets, by running their maneuvering system through the enemy positions, we allowed the computer to select those targets that they had line of sight, proper ammunition that they would engage, knowing that they were not correct. But that would give a point of reference for the Sergeants, in country to correct. So the initial simulation was not a total reconstruction or enactment of the battle, it was, in fact, designed to elicit on the spot information from the participants. We'll talk to you about how we did that and how we used it. When we took it to Cambridge, it served the second purpose of educating the scientists to the problem before we gave them a full up, functional description so they could start their technical solutions to the problems we faced while we were still gathering data. Programmatically, it was a very efficient way to do business.

Q: Do I understand correctly that they were 2nd ACR soldiers?

A: (McDONOUGH) No, no. At this point it was Gary and I fighting the battle. The question was: Did he understand correctly, that when we created the first simulation was it 2nd ACR soldiers, it was not. We took it to the 2nd ACR in Germany and we used it. That's our next discussion.

Q: Would you say that software development that you used here was mostly overriding the basic SIMNET software?

A: No, not at this stage. We used the basic SIMNET software with the immediate intervention routines and protocols that were available to us to force feed the system with the scenario that our initial analysis told us was the battle of 73 Easting. There was no modification of any software or any software work at this time.

Q: So you did not have any major new software development?

A: At this time we had none. Following us, Mr. Andy Ceranowicz from BBN will talk software development and he will tell you exactly what he did.

A: (McDONOUGH) At this time we found the control utilities used for running semiautomated forces were essentially adequate for what we had to do at this level.

A: (BLOEDORN) And surprisingly, well maybe not, hopefully not surprisingly, the SAFOR fought a pretty close battle. The first time I did it as a test, because Jim and I were very instrumental in designing SAFOR to being with. We sat them up on the line of departure in the right order of battle, against the right target array and we armed both sides, let the Iraqis fight and let our guys fight and we turned them loose, we didn't intervene at all. We just just ran them through and saw how SAFOR performed. That was very instructional to us, it told us how we could deal on the margin, it told us what to change. And surprisingly, the battle came out very close to the actual battle except as the 1st Infantry Division noted, SAFOR fought better than the Republican Guards.

McDONOUGH: The thing about it that surprised me at the time, it was not obvious to me a priori, was the fact that after we did this it became a quality control. Because built in to the SAF was logic. The SAF, if you told it to drive at 10 km per hour, that's what they did. If you told them to shoot at somebody, they would if they had line of sight and they wouldn't if they didn't have line of sight. So as we put our perception of the battle into this thing on a detail by detail basis where we had been looking at the trees and even the leaves before, now we had to look at the whole forest all working at once. The SAF showed us, in some cases, where this could not have happened the way you say because these guys are bumping into each other and they didn't bump into each other in real life, or these guys can't shoot at these guys and they claimed they did in real life. So now we knew where our errors were as Jack was pointing out yesterday, there is some stuff that we've got that we can be almost certain as ground truth and there's other stuff that's a little flakier and there are categories of information that have more and more levels of uncertainties. This was a terrific tool, I thought, to isolate those areas where we needed to do the most research to get back to what really happened.

Next slide:

SLIDE 18: USE 3D VIEW TO VALIDATE GROUND TRUTH

- Commanders Refight Battle In SIMNET
- Peer Group AAR of Simulated Battle
- Errors and Omissions Corrected On-Site
- New Data Analyzed To Refine Ground Truth

BLOEDORN: So we had a technical approach to the Battle of 73 Easting while we were still collecting data. I will turn it over for a moment to my compatriot again to discuss how we used the data but four things are important here. First of all, these guys were good enough to fight the battle, so what we did, instead of being in any kind of a structured interview, we told them the objective of our visit. We had one day with each troop down to the vehicle commander level and people like the first sergeant, the FIST, those kinds of people that handled their support function. We told them the tools that were available to them. The tools were one of these machines, where they could get a complete plan view display, an out the window view of their battle on the terrain provided by ETL. Secondly, we gave each platoon a terminal, where they could review the battle as it was being played at the platoon level and discuss among themselves where the technology or our simulation departed from the reality of the battle as they knew it. Two things were accomplished here, one, we used their own chain of command strictly, and conducted the exercise under their own commanders, we were simple notetakers at this stage, and two, by providing them with the out the window view they could go down on the ground or on their very tank, (because remember our stealth vehicle allows us to put them back into their very turret) and have the computer drive them along that route as they observed things like enemy vehicles firing at them, the berm locations, etc., that they experienced in the actual battle. This allowed them to tell us where we were off, right or left or up or down or what happened. They had all day to do this, and we answered questions and we told them that there was just one requirement that they owed us in return, after the fight was over they had to diagram and provide us with written and oral corrections to the battle we had provided them. But they had to do it in front of a peer group, and that's my second bullet. This was

maybe the most important thing of all right here. We found out that left alone, if you talked to one of them outside, he might deviate a little bit, that he fired a little faster than he did, or that he shot a little more than he did, or that they did something that the adjacent platoon might not agree with. So by having to present this in front of the entire unit, and the commanding general of the armor center came in and sat through many of these sessions, while they were going through after action reviews (AARs). Next envelope slide.
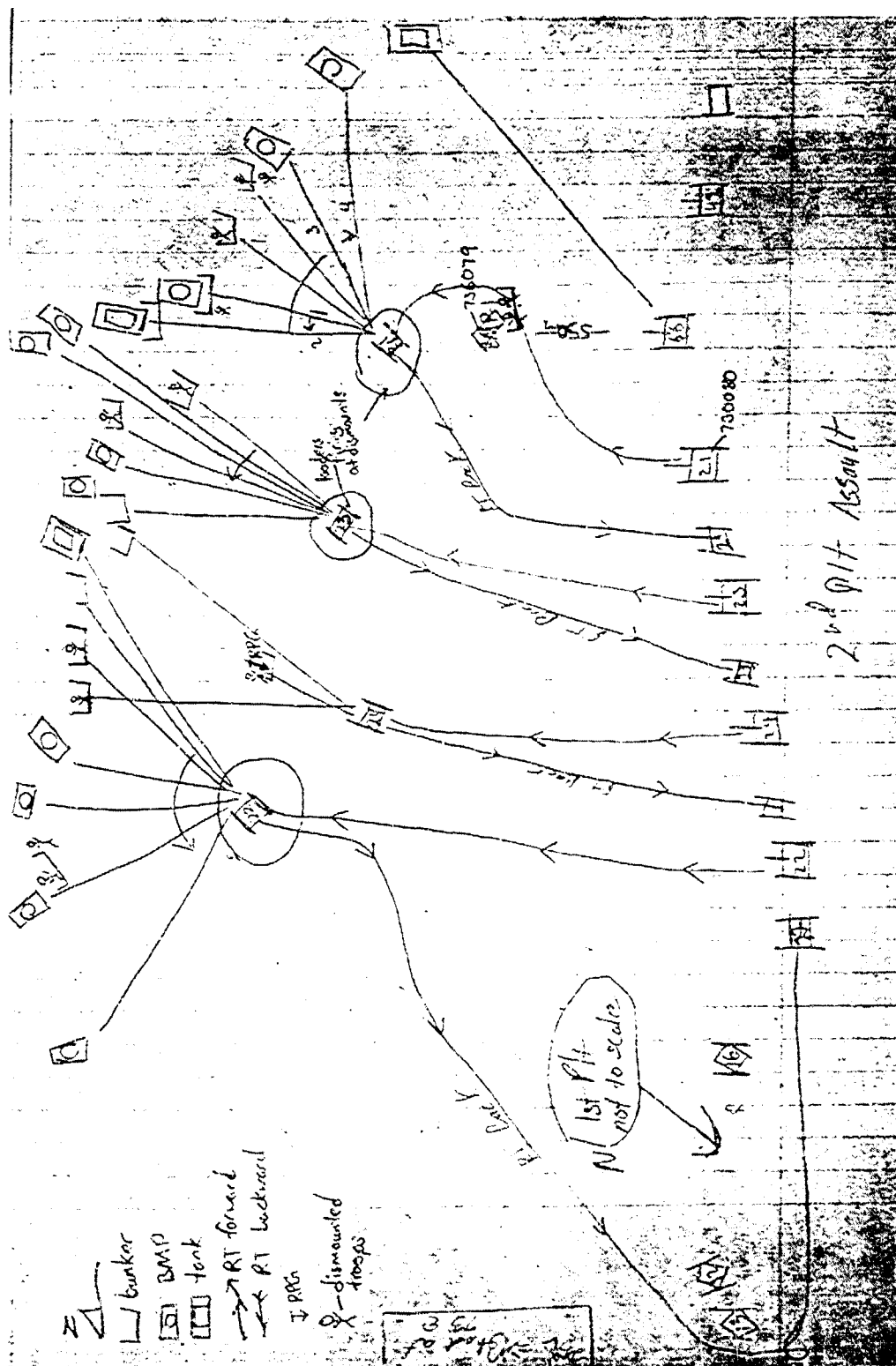
ENVELOPE SLIDE 5: 2d Platoon of Ghost Forward Movement

Here is one example of a 2nd platoon of Ghost moving off their defensive position through some smoke. After Jim gets done discussing where we're at, we'll show you how we took this sketch, converted into digital format when we returned and then we'll show it to you in the simulation. We'll try to actually take that platoon and that sketch that you see there. You'll see loaders firing at dismounts, each location of where the 1st platoon elements were, where all of the 2nd platoon vehicles were, their routes out into the counter-attack, bunkers, enemy vehicles, dismounted actions, all of the things that they drew for us and presented to their peer groups to refine that specific one little action in the battle of 73 Easting. Jim...

Put the last slide on again please.

McDONOUGH: I think Gary said most of what needs to be said about this exercise, but a couple of observations. One, that slide is slightly misleading, we did not have them refight the battle. The battle had already been refought at Fort Knox and Cambridge and we just had them review the battle as we thought it occurred from whatever perspective they wished. One of the things that this tool provided to them that was invaluable was a sense of context. Winston Churchill once said "Getting shot at wonderfully focuses the mind" and all of us who have had the experience know that but also focuses your attention down very narrowly. It allowed them to go back to where t were, see their own vehicle doing what we thought it was doing, see what everybody e₁ was doing, and try to make sense of what they were doing in context. They also reviewed the initial testimony they had given over the desert. This was enormously useful to them, I believe, in getting straight in their heads what happened. And for us in getting straight in our heads, what happened. The procedure we used was to take them, through the out the window view of the world, to see their troop's battle. Each troop was given to us for a day. We had the troop commander, his officers, his NCOs, his vehicle commanders, and

2nd Platoon of Ghost Forward Movement
(Envelope Sketch #5)

all the key people. We brought the troop in in the morning, Gary discussed the fact that he wanted the chain of command to run the day. We explained the tools a little bit, turned them loose on this thing and had our own stealth pilot fly them through the battle, and we told the troop commander, this is your helicopter, you can tell him to go any place you want and gather around this thing and review the battle out the windows of your helicopter end to end. They did that and during the course of it, that generated a lot of discussion and we allowed them to go back and forth as many times as they wanted to in time travel to look at aspects of it again. That usually took about 2 hours. Once that was done and they understood what was going on and they had looked over the shoulder of the stealth pilot at the plan view display we then turned them loose, platoon by platoon on their own plan view displays. Each platoon's worth of folks had one display station, which worked out OK, it meant about 5 or 6 people were clustered around one machine. They ran their own battle as many times as they wanted to at the platoon level. This usually took 2 to 3 hours. Then we went around and tried to be facilitators of the conversation, in that if we heard one platoon saying one thing that we thought deviated from what another platoon was doing, we'd walk over to the 2nd platoon and discuss it with them and try to bring the two leaders together. Generally, not trying to impose our opinion of what happened on anybody but facilitate between them.

BLOEDORN: As a matter of fact that point should be emphasized over and over again. We had to be very, very careful that we did not tell them what happened in that battle. We really had to sit back and let them have command of everything. We were telling them what we thought when we gave them the simulation, so it was time for us to be quiet and let them do all of the development of this thing.

McDONOUGH: At the end of the day we had them stand up in front of God and everybody and at the platoon level, say what happened. Each lieutenant got up and briefed his platoon's battle and called upon his vehicle commanders to annotate or embellish his briefing. That was a tough audience because the guys they were briefing to were their peers and the adjacent platoon, so if somebody got to the point where he was John Wayneing it a little bit he would get raised eyebrows and quickly go back to reality. It was a terrific, terrific reality check. What we took away from there was a whole lot more paper of the type that Gary showed you in terms of lots of sketches that says no, no at this point move these guys farther down there and make me go around here, in the form of documentation we had each platoon hand write a narrative of what they did broken down into what they did. We picked the key points in the battle and we had a narrative written by

either myself or Gary who would be eavesdropping at the end of the day's discussions. We also talked to Lt. Col. Kobbe, who was the squadron commander. He gave us some insight into the battle as he saw it; he was up front most of the time. We talked to the FIST of Eagle Troop, especially Lt. Danny Davis, who was absolutely invaluable. He hooked us up with the artillery battalions, got all the firing logs, did a second transcription of that tape that you heard a smidgen of yesterday. Elaine Coburn, our behavioral scientist and transcriber extraordinaire at IEI, with my help, tried to do a transcription of it and we had a real tough time.

BLOEDORN: A data point for you here though is the artillery logs now that we got, different from the ones in country. Keep in mind we now entered their data stream, their after action historical effort, to the post battle era. They were back in the states, they had completed their own after action reports, and so now they actually gave us updated logs from those that I had brought back with me. And for all of you who ever get involved in this, I urge that, do not take what you get on the battlefield as gospel truth, you have to follow up after they've gone through and then compare the results. And we did that also.

McDONOUGH: Danny's transcription of at least the key 30 minutes of Eagle Troop's fight was a real Godsend. It became a rosetta stone for us because it pulled out a whole lot of stuff that we haven't been able to hear, a lot of which was location reporting, which we now had tagged to absolute time, as everybody knows, people's perception of time in battle is tremendously distorted. Short times seem to be long times and long times seem short. That was probably the least reliable testimony we were getting. Here we had a contemporaneous record that was running in real time, we had people calling on the radio and reporting, 1 am at grid 123456, Danny told us, specifically who had a GPS system and so we knew that if we heard that the call sign was 11 I'm at so and so, that that was valid data because 11 had a GPS system. We knew that 13 did not have a GPS system. So we assigned that data a little less validity. We were able to find some of these anchor points that Colonel Thorpe was talking about yesterday and then do something that the intelligence folks call template matching. We knew generally from the testimony what their formations were, we knew they were trying to keep about 300 meters between vehicles, we knew they were in a wedge, we knew for sure that at 1618 Danny Davis was here because we got his transcription, that he's reporting his location. We knew that he was on the left side of the wedge. We would make a transparency, put him there and rotate it around so that everything else started to make sense in terms of target fire pairings, and everybody else's testimony and so forth, so that became very valuable.

here on this size is 100 meters I believe on this scale that we have. Yeah, this is 1 over 3 125's so you've got 73 1, 73 2, 73 3, each grid side is 100 meters on a square.

Q: Are you going to replay that?

A: Yes, he is, he's just getting control of his machine. We're going to show it to you and let you see the action as it develops. It's crucial for you to understand how we convert all of this and we'll talk about how we communicate with the software developers to get those positions located and get the battle going. We'll show you your perspective viewpoint on the monitor.

Q: Could you say what time it is?

A: Yes, the time is around 1630, 1640 in that area when the action started. The actual first rounds were fired on the position here with Ghost at 1630 hours.

Q: When was EENT?

A: EENT? I'll have to look it up. I'm so lost in the data, it was shortly thereafter on this day. It was very dark, cloudy and accentuated the effect of EENT--it was sometime after 5:00 o'clock. But it was very dark and gloomy out here at this time. But visibility had improved dramatically because the wind had dropped. Keep in mind, when you hear wind velocities, that it had been raining and so it took much more wind this day to stir up sand than it would on a very dry day.

Q: Those vehicles are about 50 meters apart now.

A: Yes, exactly. These are 100 meter grids and this is one of the few times that the tanks were very, very close together. Their normal operating distance was about 300 meters apart, here in this fight, they were going out alone leaving the troop and they tended to bunch up quite a bit.

You can see them as they move forward, they uncovered more targets. You'll see them starting to fire, you'll hear them fire, now with the sound system up, the track noise. Now, if you could attach us to the platoon leaders vehicle, GOLF 21, for a moment and give us that viewpoint, see what the lieutenant saw. You're following right behind the platoon leader where the arrow shows you then he'll be in the right monitor. We'll be able to see the data as it is developed...as they go. Believe me they move that slowly out there...they were feeling their way out ahead of their own troop, they didn't want to go too fast, it might stimulate fratricide. They wanted to get out and see what was going on. The special effects that will be added to the simulation will reflect what you're seeing

BLOEDORN: I hope you'll find this interesting, can we put the previous envelope slide back up please. I'd like to show you this action which is the 2nd platoon Ghost troop, 2nd squadron, 2nd cavalry, that had pulled up ι position, there was one BMP about 300 meters in front of them when they pulled up, three M1's fired almost simultaneously, the 21 the 22 and the company commander's vehicle, they put three 120's into it. It started to burn fiercely and obscured the enemy to their front. So the second platoon leader charged through the smoke out into the enemy array.

ENVELOPE SLIDE 5: 2d Platoon Ghost Troop Movement Forward

I'd like to show you in simulation that action, take you out to the battlefield, and let you see that diagram on your right as it is in the simulation now. So you can judge for yourself its accuracy and validity. The tanks are lined up, Ghost troop is on the 73 Easting, there they go, they shoot this guy here H4, he starts to burn, burn, burn and now we'll see the 2nd platoon that goes out in this location to get the rest of these targets because this guy's covering it now with smoke. You can see them moving out there, you can see the burning vehicle, you can see that here in the simulation, where they're on this particular location right now and they're moving out forward to engage all these bunkers and vehicles. Notice here that I have exact coordinates of that vehicle by GPS. We've got the exact location of that vehicle, there's the 66 vehicle right there. There's the BMP that they shot with a bunker in front of it. And you'll see their routes where 21 goes around the burning vehicle to here and you'll see them engage. As you see the four moving the 21, 24, 23, 22 and you'll see them move out and those are the same vehicles by numbers that you see right there. While we're watching, an aside, you'll notice that 22 on the right flank, he fired almost every round he owned and some of the other tanks only fired one or two. That's the spread of actions on these vehicles on the battlefield positions.

Q. In reality at this point, does everybody see everybody?

A: Yes, they could. At this time of night the shamal had dropped dramatically and there was visual contact between their own elements. However, it was getting dark and they were relying on their thermal sites.

Q. Could the Iraqis see us?

A: Oh yes, as a matter of fact, they killed one of our vehicles shortly after this, this is where we lost E16 in this action. The smoke was blowing from the south to the north and the reason they moved forward as I say, was to clear it. Each grid that you see

here...bunkers, wind velocity, the angle of the smoke clouds and the dismounted infantry actions that you see on my right slide, they have been located and we have the positions and the sequence in our data. They have not been implemented yet in software at this stage of development.

Q: Are they using daylight or thermal sights at this time?

A: They're using both at this time, there is a lot of fire out there now and some of it was causing blooming in their thermal sites so they went to their daylight magnification. The tanks commanders, in almost every case, stayed up in the turrets and gunners control the turret movement.

Q: Is this the commander's view?

A: Yes, sir. You can see the gun tube, you can see the firing up as a result of their initial firing. This is gunner's view...what occurred now, because the vehicles were fired up and many of the Iraqis...these are BMPs out front as opposed to tanks, most of them...and the crews were down in bunkers. So the crews got out, where you see on my slide, we had the dismounted actions coming out of the bunkers.

Q: Those burning enemy vehicles were not in a revetment?

A: No, in this case they were not. When you see them out of a revetment they were not in a revetment. But I'll caveat that with saying that we have a quality control check where we check each one of the pieces of ground and those revetment should be in there now, if they were present on the battlefield. We'll be going through it and if there is a revetment that's in our sources it will be put in there.

Q: Were they advancing?

A: No, no, they were sitting back there doing very little of anything when our guys got up on the 73 Easting. One of the mysteries of the campaign is why the Iraqi command and control was so disrupted that they didn't get warnings out and organize a counter attack of any kind.

To us this appears to be very slow. To them, it did not, the time was filled with acquisition, movements, commands and radio nets. When we fly free you no longer hear the vehicle sounds of the tracks that are going on there. You can see the results of why they went through, and why they went forward to get at them because you see the burning enemy vehicles in the...I must point out again, the data shows they fired very few rounds and that's why you are seeing a battle that doesn't look like other battles, where we had air,

napalm, bombs and rockets. They went forward, they acquired targets, the killed them, they came back.

If we could show on the plan view display and spread us out where we can see all of those targets that have been killed that would help.

There's the plan view of the battle as you see it, and you'll see how the platoon's action resulted in a very rapid destruction and we have round by round count in the data base of the engagements and the time.

Q: Were there any incoming during this period?

A: Yes, sir, they did. As a matter of fact this was the location and when they got back, if you want me to play it that far I will, on position, the Iraqi artillery opens up with very accurate fire, directly on top of them, 130mm fire causing their trains to displace about 1 km to the southwest. Our counter battery fire was so quick that the testimony of the soldiers was that they just ducked down in their turrets and didn't even button up. There you see one of the revetted vehicles so my answer to reinforce it.. where there were revetments on the battlefield, they are on the terrain data base. Take them up to that revetted vehicle. That's one because he was revetted maybe, he has yet to be killed.

As we develop the dismounted infantry actions, you'll see them on my slide coming out of those bunkers in diagrammatic form. We will be placing the correct numbers of infantry as the testimony calls for and their activities. In this area they were attacking. And they continued to attack until they were killed, one of the reasons why the Tawakalna did not yield many prisons of war. At this stage of the game it was all our side, very shortly in the battle, the enemy returned to the attack, when he got his wits together and organized a counter attack from the north and ground attacks through the center and these lads were busy all the way until about 2130 that night repelling counterattacks.

Q: Is it true the Iraqis had some M113s?

A: Right. There were some Iraqi M113s on the battlefield, where they got them, I do not know. I do know they had them. There were some special purpose vehicles that the Iraqi Army had and they were M113s, painted with Iraqi markings. The Corps Engineers destroyed those as they did Russian built equipment.

This was just one vignette to show you how we converted data that we received from the simulation back into the simulation. Next envelope slide please.

ENVELOPE SLIDE 6: 2d PLT Ghost Troop Return to 73 Easting

This is the follow-on action which I could show you as the 2nd Platoon pulled back to the 73 Easting. You'll notice that it also includes not only the withdrawal route of the second platoon after they come back and a repositioning to take the counter attacks that are coming from the north, it has the time they come back, who led, the route they took, the coordinates, when they went in front or rear, incidents that happened as they went into the battle and it shows the entire dispositions of the first scout platoon to repel the counterattacks that came in. We went though a similar drill to convert that to the animated fight that you see on both sides. It was this action, the enemy target array and the Ghost sector around the 73 Easting line up in the north. This was the only time that the Iraqi's mounted a sustained counterattack effort and there was very heavy armor and BMT attack supported by indirect fire and dismounted infantry assaults. This sketch shows the repositioning of equipment in time and location and sequence to repel that counterattack. We take those data points, rates of movement, rounds expended, times and sequence and that goes into our history.

Q: Were you able to modify when you were interviewing people in Germany?

A: Yes and No. I did not modify my basic simulation at the time but I was able to use the semi-automated forces in the workstations there to stage those simulations in real time as the platoons fought them. They were able to use those to illustrate points as they wanted to do so. We had both capabilities, but I didn't modify the basic data logger tape.

Q: Do you have any enemy logs?

A: We were briefed by Colonel Kobbe, he showed the overlays that they had captured by the Iraqi forces but they were at a level of abstraction and inaccuracy that they were useful to the historian who was going to write the story but of limited usefulness to me.

Q: Did the Iraqis execute their doctrine?

A: The comment by Gen Funk was that they didn't execute their doctrine. They had planned well and were doctrinally correct in planning but they executed poorly. When we compared that with the ground truth we went with ground truth. Does that answer your question? We didn't have all of the documentation we would have like to have had, I must say that also.

2nd Platoon of Ghost Troop Return to 73 Easting
(Envelope Sketch #6)

Q: You mentioned that one tank fired almost all of its rounds, while some other tanks fired very few rounds. Did you do an analysis of which tank killed the most enemy targets versus rounds fired perhaps why they were more successful?

A: To the former question, we did do an analysis. Simply by printing out our data that does the analysis I have by type, by target, so the answer to that is yes. Secondly, one of the reasons is the position on the battlefield. As an example, the Ghost 4th tank platoon, one of the most powerful units on the battlefield, fired seven rounds. The two scout troops and the other tank platoon did 95 percent of the fight on this location. The reason was where the troop commander chose to station that tank platoon, because he was concerned about that area, there was simply no action and he did not move it. So they got very limited opportunities to engage targets. Plus we had one of the only documented occasions that an M1 main gun failure occurred in the 4th platoon. The platoon leader fired one round and his main gun malfunctioned and his firing circuit. A very rare occurrence by the way, but we know when it happened and we know where the one round went.

Q: You mentioned tank tracks, how well were they preserved when you got to the battle scene and had there been a lot of other traffic through there, were you able to get much information from the tracks?

A: We got quite a bit of information. Luckily in the battle of 73 Easting it happened in a very remote section of Iraq, the shamal stopped about simultaneously with the advance, where most of the combat actions occurred the tank tracks were readily visible to us, plus we could follow each one of the armored vehicles by where they had stopped to do what they call a reload drill, they would shift onboard ammunition to ready racks from storage racks and dump the spent brass and cartridge cases as well as the TOW cannisters they would throw overboard where they reloaded TOW and you could see from the firing position you could actually take an azimuth shot along the TOW wires into the flank of the enemy positions. I want to make sure that you understand that's not true in every case. What it was was in enough cases to help us set the context in the initial simulation where they filled in the blanks for us.

Q: The simulation shows who shot which Iraqi vehicle. How did you track how well he shot at us?

A: What we have with the enemy firing positions, we have three sources of data. The first source of data is direct testimony. I pulled up to this firing position and that tank shot at me with a main gun round and then 22 came up and blew him away. Or in the troop

vernacular "lit him up.". That became their normal descriptive term when you read our transcripts and all they'll say "Well, I lit him up." The second source of data we have is the actual spent brass and ammunition picked up at those sites and those sources, so we know they fired. Who they fired at is less concrete than we have from the friendly side. Since they only hit one vehicle, it was very difficult to track them. I'm glad you raised the point. When you see enemy firing, in the simulation, it is to the best of our ability, a directed, in the closest 45 degree quadrant since it didn't hit anything, in every case, they missed, except for one Bradley, but we didn't go through the drill of trying target firing pairing with the rigor we did with U.S. units. But we did go through the rigor when I had direct evidence or testimony as to what they were firing at. It helped, when you see the enemy vehicles, you'll see an orientation of their hull, and an orientation of the berm. The berms were so high they could not fire the main gun forward. They were apparently depending upon the berm to protect them, either from acquisition or from the effects of our fires, both cases proved illusory. Or they were simply trying to hide in their locations. So they only fired from left to right. Now this caused them tremendous trouble because the T72 tank has an automatic loader and it cycles back to the front after they shoot. So they could only shoot off to the right, shoot off to the left and you'll see the berm orientation and the vehicle gun tube orientation in our scenario as we go through the enemy position you'll see that we have the orientation of the turrets and the hulls. That showed me where they fired, and indeed, they died in that location. They died very quickly and it looks like the turrets were firing on that azimuth. What I would like to do next, is show you the data trail. Jim, if you'd like to come up and talk them through a couple of ODIN screens, and Anthony, can you put that same ODIN screen up for that battle? This will show how we used the simulations to convey the data to our software engineers.

McDONOUGH: This afternoon from LCDR McBride you'll learn more about ODIN, those of you who don't know much about it. ODIN was developed as an effort to quickly apply this technology to possible utility in a command and control mission rehearsal, mission planning role in the gulf war. It was much more user friendly than the initial SIMNET suite of equipment in terms of laying down forces on the battlefield and tweeking them around. It was much less user friendly in terms of its integration with SAFOR, but it generally allowed one to fairly quickly build a static picture of the battlefield at any moment in time, by picking icons out and drawing control measures and so forth. What we did when we came back from Germany was essentially a redo of the same tasks we did when Gary came back with a seabag of information from the desert. We correlated all the new information we had and came up with notes and updates but instead of drawing

elaborate graphics and timelines this time, we took partially processed data up to Cambridge and Elaine, Gary and I sat down with the scientists who were going to have to execute this simulation and using ODIN as the tool to create our graphics, began to develop snapshots of what had happened. We laid out for 1530 which is when we started documenting things, this is where Iron Troop was, and we laid each vehicle out on the terrain and we did the same for Eagle Troop and the same for Ghost troop. Then, we moved ourselves up to 1533 or whatever the next significant event in the battle occurred, which was often a period of two or three minutes--sometimes it was a period of four or five minutes. We extrapolated where they were at that time, based on time, distance calculations and our notes as to what the intervening events were and we drew the next snapshot. We just continued to do that basically the way cartoonists cells in creating animation over the course of the entire battle from 1530 to around 2100 or so.

BLOEDORN: There is one comment that I would like to make. Please look at this slide.

ENVELOPE SLIDE 6: 2d Platoon Ghost Return to 73 Easting

Here we have 66-23, 21, 24, 22 when they came back and here you've got the same vehicles here. So what we could do was quality check the simulation forces as we put it in there and compare it to our data. These are two different data points, notice two 3's on the right flank here and two 1's on the right flank there. The reason is that's before they went out. They came back in and they switched positions. But we are able to track them. O.K.

McDONOUGH: This serves several useful purposes: First it was a whole lot easier way to draw graphics than using rulers and little templates to scribble things, secondly as Gary pointed out earlier, again it involved the software engineers who were going to have to do the intervening animations between cells in what happened and immerse them into the data in a total immersion type situation where they began to understand what really happened in the battle or what our perception of what really happened in the battle was. The third thing is it is source data automation, at least to a degree. It captures the input from the analysts who are dictating what happened in a digital format that can be then quickly extrapolated by using the SAF movement rules and various other tools of animation that the software scientists have into the actual real time simulation.

BLOEDORN: I think we're almost out of time and I want to talk functional specs, show them a copy and give it a couple of minutes, then we're going to bring Mr. Ceranowicz up and tell you how he actually used this input. Next slide please.

SLIDE 19: FUNCTIONAL DESCRIPTION

- **Refined Data Used as Basis to Define Simulation**
- **Detailed Guidance to Software Contractors**
- **Published Simulation Capabilities**

McDONOUGH: The next thing we did was having now plotted the battle to a level where we're fairly confident that we're at the 85 percent point in terms of where everybody was, and who shot when. Having examined the simulation that exists we developed a functional specification to tell the software designers what they had to do to get from where we are now to the finished product, 73 Easting Simulation. That included specifics on what new simulation attributes were needed, in terms of the visual system, dynamic models that it portrays, static models, the terrain data base portrayals, and special effects. What special effects were needed that aren't there now, the effect of wind, different kinds of explosions, turrets flying off tanks, several other things of that nature, dismounted infantry--as you notice as you've flown around the data base in the last couple of days, you see the occasional lone soldier, there are more dismounted populations we're going to have to put in. We've also listed encyclopedic data base requirements. In SIMNET, as it exists now, and in ODIN, one can query particular icons and get a tabular display much like a Macintosh puts up a little dialogue box of things about that vehicle, its ID, how much ammo it has, etc. In this case, we needed additional data, for historical purposes. You may want to put up a query and find out who the tank commander was, so we defined additional encyclopedic data bases that might be required. Finally, required attributes of the sound systems don't exist now. In the existing SIMNET things like machine gun fire, explosion of DPICM munitions, where one explosion occurs in the air and then a ripple of explosions occur on the ground, don't exist and need to be developed.

--73 EASTING--

CONSTRUCTING THE SIMULATION

Dr. Andrew Ceranowicz

BBN Systems and Technologies

DR. ANDREW CERANOWICZ: CONSTRUCTING THE SIMULATION

So far, you've seen and heard how the data was collected, both the battlefield events and the terrain data, how it was reduced to a coherent set of events ordered in time and space, and how the terrain database was constructed. I'm going to talk about how we used that data produce to a representation of the battle that you can observe from a three-dimensional perspective view or from a two-dimensional map or plan view. The title of this talk, "Constructing the Simulation," implies that you have been watching a simulation (Slide 1). I would like to make a distinction between the process of creating the simulation, reenacting the battle, and the process of presenting the results of the reenactment. What you've seen here in the last two days is actually a presentation of the reenactment. The reenactment itself was done up in Cambridge last week.

SLIDE 1. CONSTRUCTING THE SIMULATION

Constructing The Simulation

Andrew Z. Ceranowicz

SLIDE 2. REENACTMENT TASKS

Data Collection

- Battle
- Terrain

Terrain Database Construction

Data Reduction and Analysis

Simulation

- Initial Conditions and Mission
- Battle Reenactment
- Recording
- Special Effects

Presentation

Slide 2. The reenactment uses the information from data analysis and the terrain data base to generate a set of initial conditions, showing where the units started out, and a set of missions that describe the evolution of the battle over time. These missions are then executed to generate the battle reenactment and the results are recorded for later presentation. Special effects are going to be added to enhance the presentation. They will show battlefield conditions, such as visibility and illumination, and they will provide more realistic depictions of some of the weapons effects. It is important to point out that the flow of information in this process is not unidirectional. Just as information flows from data collection to simulation, it also flows back up. By watching the presentation, we find flaws in the reenactment, by doing the reenactment we find inconsistencies in the data analysis, and by doing the data analysis we find where information is missing. It's very much a feedback process, which incrementally improves the quality of the reenactment.

SLIDE 3. REENACTMENT APPROACHES

Presentation

Fixed View Point vs. Viewer Selectable

Snapshot vs. Scene Based vs. Continuous

Regiment vs. Troop vs. Platoon vs. Vehicle Level

Lifelike vs. Abstract

Live vs. Recorded

Production

Acted vs. Animated vs. Simulated

Segmented vs. All at Once vs. Evolved

Slide 3. The presentation that you've seen is unlike movie presentations because you can move around and watch any event in the reenactment from multiple points of view. You are able to watch an attack from the US side and then see what it looks like from the Iraqi side. This is important because from one view, an event may seem completely inexplicable, while from another view, it may be very reasonable. So you want to be able to do that kind of analysis to understand the data. To do this, you back up the simulation, move to a different viewpoint, and replay the event. With two presentation systems, you could watch from both viewpoints simultaneously. To allow you to do this, the reenactment must provide a three-dimensional representation of what happened on the battlefield so that the view from any point can be computed.

The progression of the battle can be presented in a variety of ways. You have seen a snapshot presentation of the reenactment as a sequence of map views of the battle over time. You've also seen vignettes of short portions of the battle in three-dimensional perspective. Yesterday you saw a continuous map view of the reenactment from the beginning to the current end point. This is still work in progress and there are still many extensions and adjustments that need to be done to the simulation to bring it to its final format. The separation of the presentation of the reenactment from its creation allows you to choose the type of presentation when you watch the battle. The ability to pick your viewpoint, the perspective versus the map display, and the method of moving through time, can be referred to as interactive presentation. To support this, the reenactment representation must be continuous in time as well as three-dimensional.

Another variable of the interactive presentation is the level of aggregation that the presentation uses. The presentations you have seen have shown the battle at the vehicle level. In addition, we can show it at platoon and troop levels for the U.S. side. We don't have enough organizational information in the simulation to present it from higher U.S. echelons, such as squadrons or regiments, or from any of the Iraqi echelons.

You have probably noticed that the tanks in the presentation are rather abstract cartoon-like depictions. Interactive presentation forces you to store the battle in an abstract, continuous, three-dimensional representation and to construct the presentation in real time. It is not practical to store images of all the possible scenes and viewpoints that a user might want to look at. We use a special purpose processor called a computer image generator to construct the interactive presentation. The drawing speed of computer image generator is limited by its computational power. To update the image in real time, you have to make a trade-off between whether you're going to draw a few highly detailed objects that look very realistic or more less detailed objects. We felt that showing the existence of all the vehicles on the battlefield was more important than drawing only some of them very realistically. Therefore, we use relatively low resolution models. However, to be fair to the people who built the models, I must tell you that there is quite a lot of work involved in our current models. Another feature of separating the representation of battle from its presentation is that, as CIG systems increase in power, you'll be able to take the same battle and present with more detailed and realistic models.

The battle you've seen presented here has been prerecorded and is being played back from a device called a data logger. Since the reenactment that has been almost entirely controlled by the missions that we constructed for the units, we could have brought the

simulation equipment down here and generated the presentation in real time so you could see it created live. However, that would require much more hardware and preclude options like skipping back and forth in time and doing instant replays.

We have used the simulation approach to generating this reenactment rather than having people reenact the battle in simulators. It would have been too expensive to generate the level of precision that we're trying to achieve by repeating the entire battle over and over with manned vehicles. We also did not use animation because that would have required many commands to go from one frame to the next in sufficient detail to produce a three-dimensional reenactment. We were able to use the dynamics and the behavioral models in the simulation to interpolate between the events in the source data and generate the reenactment.

Because the size of this reenactment is relatively small, about 500 vehicles for 6 hours, we are able to generate a complete reenactment in one simulation run. If it were more than a factor of two larger, we would have to segment it into independent pieces which would be simulated separately and then pasted together later. The approach we take to improving the accuracy of the simulation is to iteratively modify the missions which describe the evolution of the battle. We add and change commands in the missions to increase the fidelity of the battle, rather than to go in and modify the data logger tape directly.

Slide 4. The technology used to produce the reenactment comes from two DARPA projects, SIMNET and ODIN. SIMNET is a system which uses computer networking technology to connect together large numbers of combat vehicle simulators so that they can interact with each other and be used for team training. The state of the world in SIMNET is described by the flow of packets across the network. You can think of this flow or stream of packets as a data base that describes the battle as it progresses. Each of the vehicle simulators taps into this data base to find out what the state of the battlefield is and then uses real time computer image generation to paint the battlefield from its viewpoint. Here you have a requirement to generate many independent views of the battlefield from one set of battlefield data. This led to the separation of the presentation from the world representation in SIMNET. It's a little bit difficult to see the separation in the simulators because what the crews see in the presentation causes them to change the state of the battlefield which in turn changes the view. However, when you go to systems like the stealth and the plan view display, the separation becomes obvious. Here you have presentations that have no effect on the state of the battlefield. The stealth is one type of

presentation and the plan view is an alternative presentation of the same data. Like the state of the battlefield, the flow of packet traffic on the network is transient. In order to capture the history of a SIMNET battle, you have to record the flow of packet traffic. This is done by the data logger which can then play the packets back and allows you to reexamine the battle.

SLIDE 4. SIMNET

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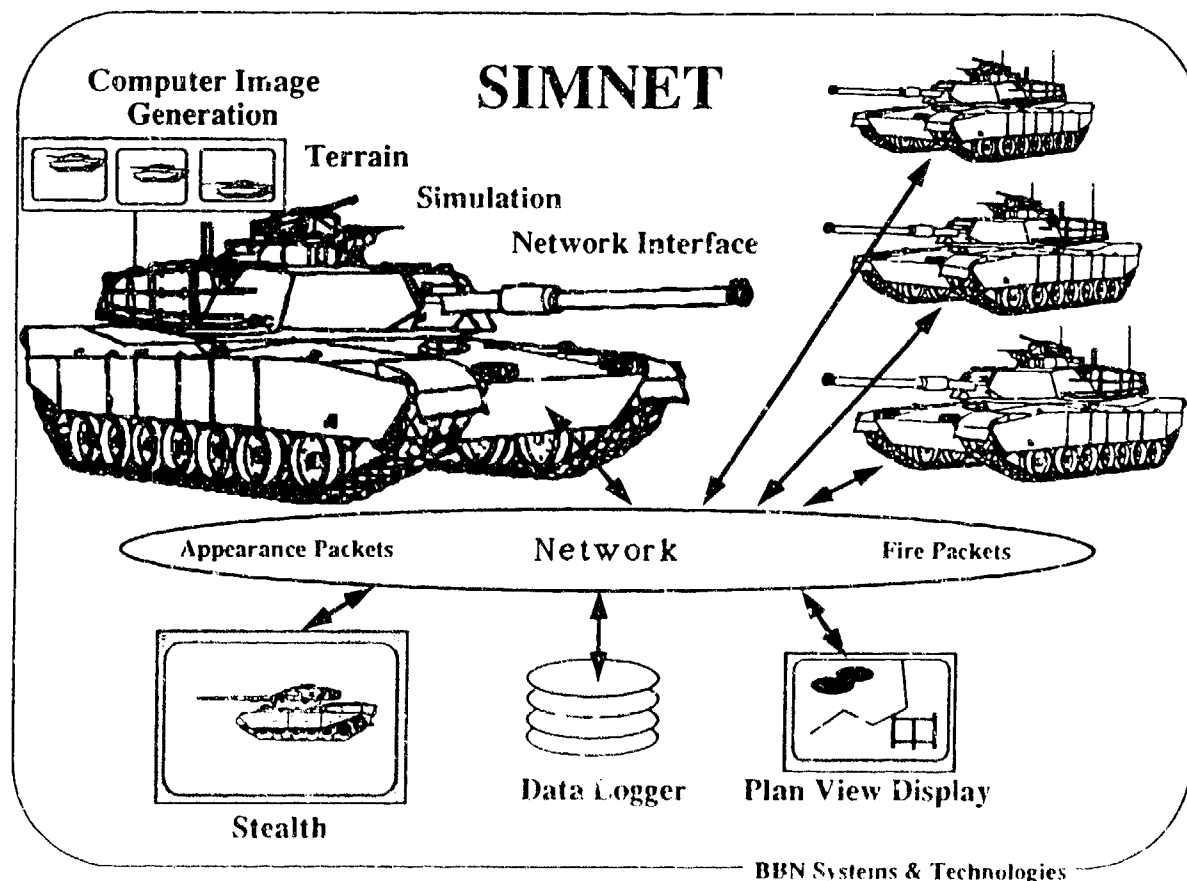
Slide 5. Another important feature of SIMNET for battle reenactment is semi-automated forces (SAF). The semi-automated forces system allows a single person at a workstation to control a large number of vehicles out on the simulated battlefield. It does this by automating the lower level decisions that the forces need to make, allowing the person at the workstation to use higher level supervisory commands to control the vehicles. All the vehicles that have been shown in this reenactment have been generated by the ODIN SAF system. There are three ways to control the behavior of the semi-automated forces. The primary method of control used for reenactment is the use of preplanned missions that are sent over to the simulation software in the form of operations overlays. You can also give direct commands to the vehicles similar to the way you give commands over a radio.

II-73

We use direct commands in reenactment only for last minute fine tuning of production reenactments which will be presented publicly. The other way that behavior is generated in the SAF vehicles is by the automated decision processes. However, in the reenactment of a historical battle, the reenactment must replicate the known historical facts. That is, you have completely specified situations, a vehicle has to come to a point at a particular time, shoot at a particular target, hit it, and the target must blow up. This sequence must be repeated every time you run the simulation. To achieve this, we had to augment the commands for low level control of the SAF and override a lot of the automated control logic to produce precise and repeatable behavior.

SLIDE 5. SEMI-AUTOMATED FORCES

Automated Reactions

Operations Orders

Radio FRAGOs
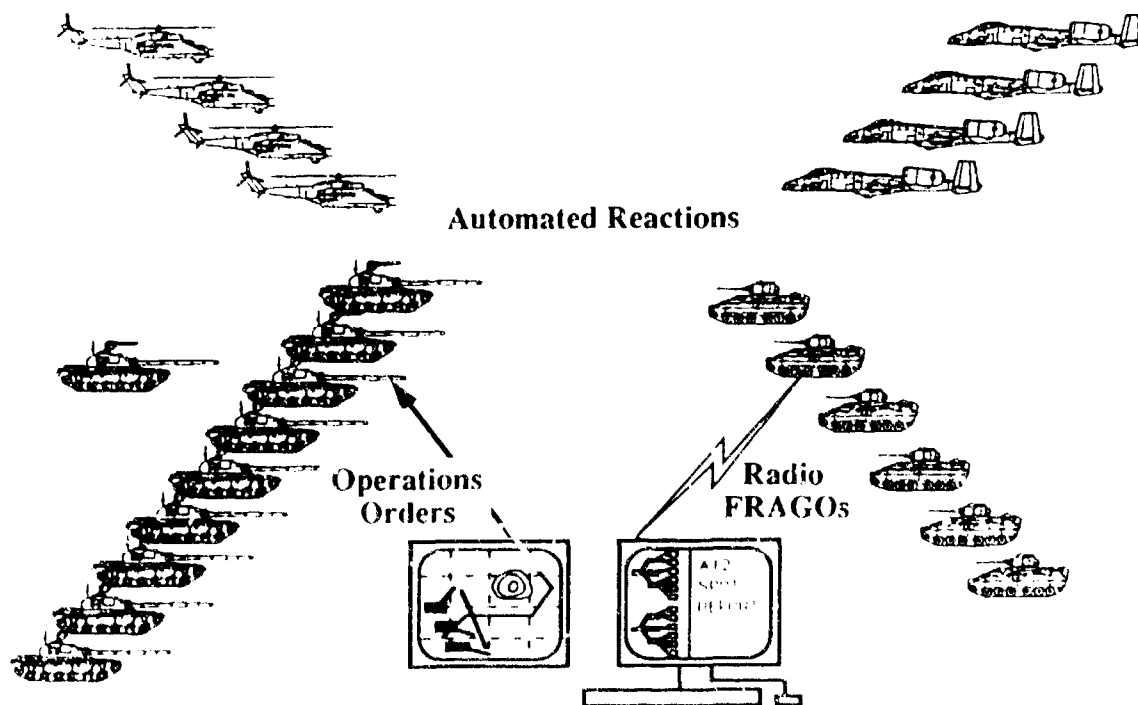
Slide 6. The ODIN system is the electronic sandtable that we've heard mentioned earlier in this conference. It is an interactive presentation system which allows you to look at either real or hypothetical data about the state of the battlefield. You can enter information about friendly and enemy vehicle positions into an order of battle generator (OBG). This information can then be presented either in two-dimensional map form or three-dimensional perspective form. The OBG keeps the information in a distributed network data base which can be displayed or modified by any OBG on the network. This network data base is different than the one used in SIMNET. In SIMNET, the world state

represented on the network at any instant corresponds to a single point in time in a single battle. In ODIN, the network at any instant contains world states corresponding to multiple points in time and to different battles or different versions of the same battle. This allows you to explore events in random order as well as alternative courses of action. The data input to the order of battle generator can be entered manually or it can be downloaded from intelligence gathering systems such as FULCRUM. In addition, the ODIN system has a SAF and a data logger to enable it to run small scale wargames from the OBG information. LCDR. McBride is going to describe the ODIN system in more detail later on today. I'm going to concentrate on those features of ODIN which were important for the reenactment of the battle.

SLIDE 6. ODIN
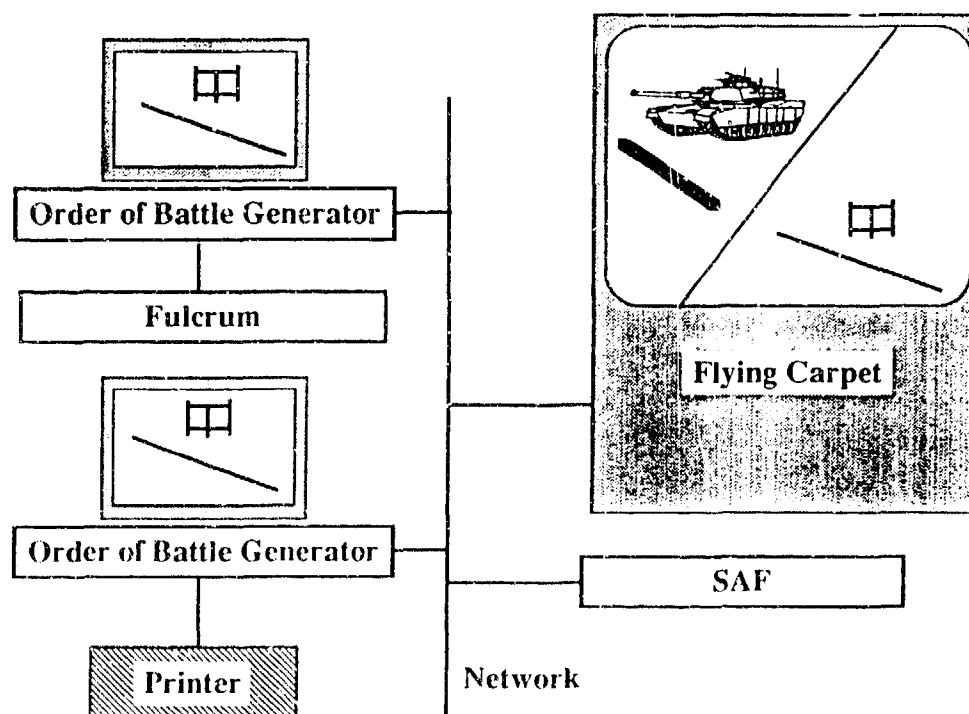
Slide 6A. The primary new feature provided by ODIN which we have been using for battle reenactment is the timeline or course of action capability. A timeline is a sequence of world states which shows the evolution of a battle over time in discrete steps. The source data we receive is represented in timelines. This slide shows a timeline control menu. In the row of buttons in the center labelled with date-time groups, each button
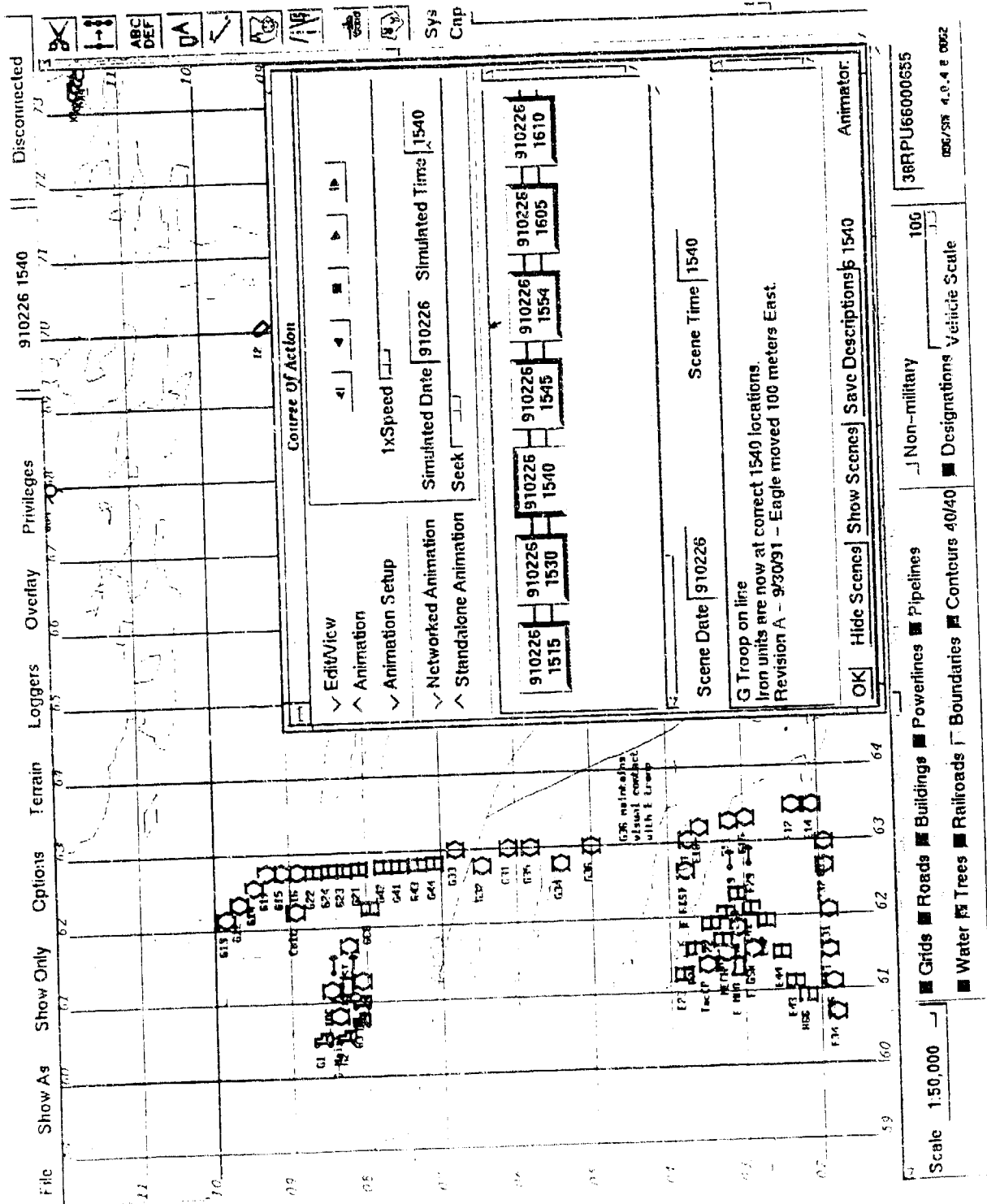
SLIDE 6A

corresponds to a world state in the 73 Easting timeline. Depressing a button displays that world state. The 1540 button is depressed in this slide, telling you that the scene you are seeing is that of Ghost Troop at 1540. You can move around through this timeline randomly by pressing any of the buttons or you can use the VCR-like controls at the top of the menu to sequentially step through the states forward or backward. You can change the rate at which you move through simulated time. You can also branch these timelines to enter conflicting data. We could have, had we decided to use an animation approach, tried to modify this system so that the steps in the timeline were small enough to approximate the continuous motion the vehicles. But as I mentioned before, we felt that the simulation approach was much more efficient.

Q: Does this time axis represent key events in the battle or times when you had known vehicle positions?

A: They are known data that is passed on to us from the data analysts. They represent known events and positions at specific times extracted from the source data.

Slide 6B. ODIN allows you to organize your data in order to keep the presentation and entry of the data manageable. You do this by placing different classes of information in different overlays. For example, the menu lists all the different overlays that are used to hold the known battle data from which we are doing the reenactment. In order to keep this data from overwriting itself and producing an illegible scrawl, we've only turned on the Eagle units, the moving red units, the Ghost units, and the dug-in Iraqi positions. We have found the overlay/timeline format very useful for entering the data and analyzing the battle by going back and forth between world states. In addition, the distributed nature of the ODIN data base allows multiple people to enter data simultaneously. The presentation that you have seen here and the reenactment that it's showing were all done using the ODIN system.

Slide 7. Let me briefly describe the reenactment process. You've heard much about it already. First, researchers went to Iraq to collect data and data base construction was started from available data. That led to data analysis quickly followed by the translation of the data into missions and initial conditions for SAF. An initial reenactment was done. That reenactment relied heavily on the use of direct commands issued in real time at the unit level. This allowed the initial reenactment to be done quickly, so it could be used to get feedback. We saw that issuing commands in real time was a difficult way to approach the problem and what we really needed was to make use of preprogrammed

SLIDE 6B
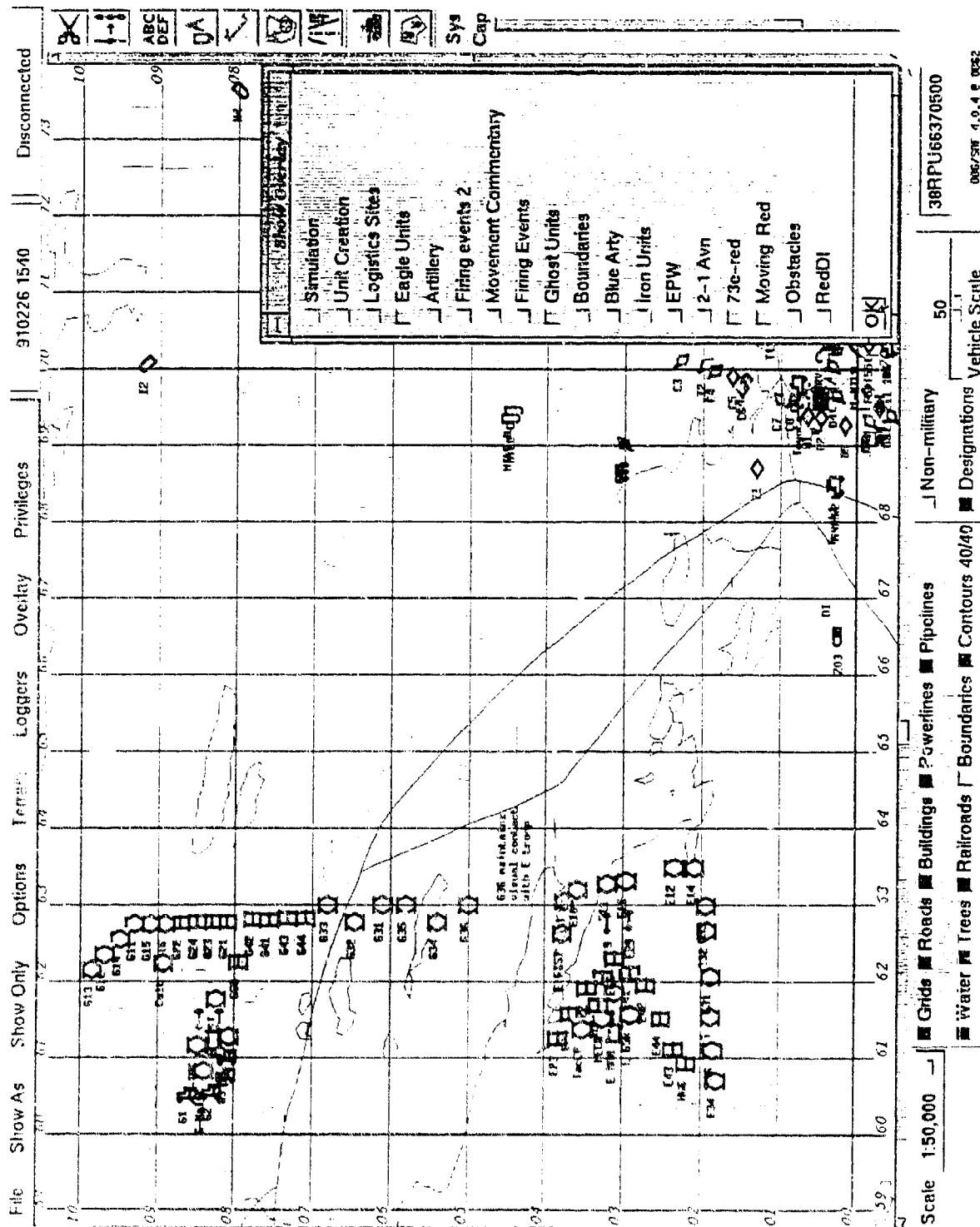
SLIDE 7. REENACTMENT PROCESS
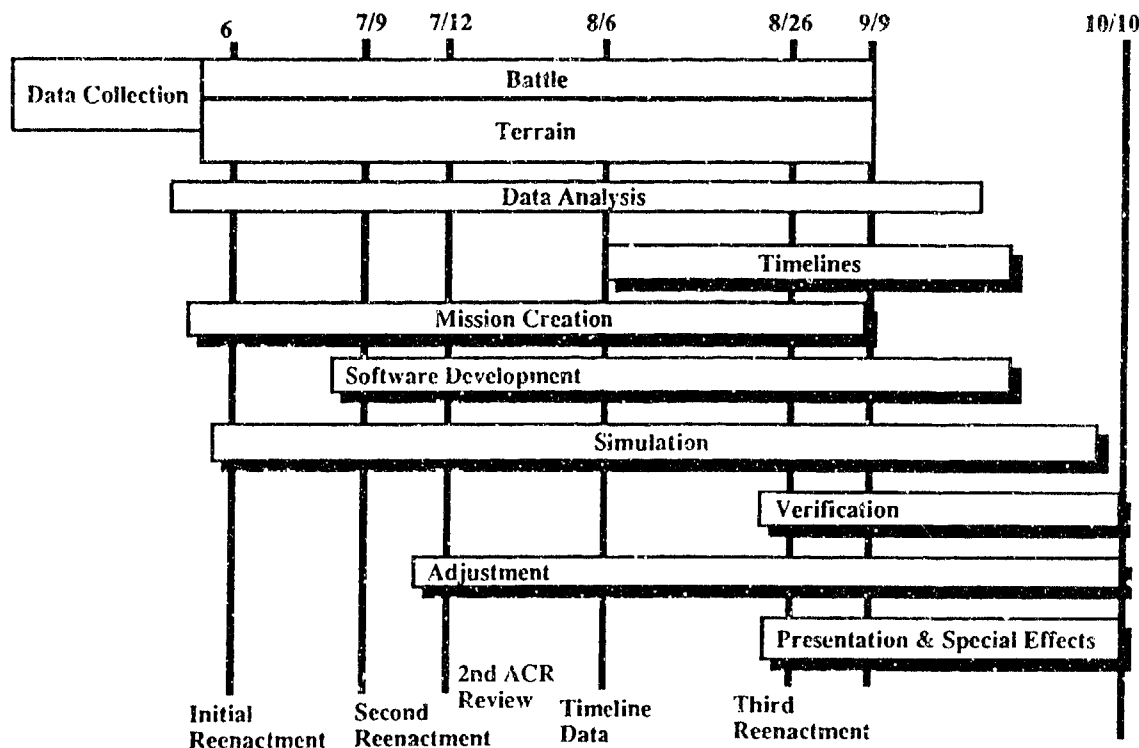
missions. So we went back, more data analysis was done and more detailed missions were created. Software development was started to allow us to represent more of the vehicles in the battle and enhance low level control of the vehicles. A second reenactment was done. That reenactment was presented to the second ACR for review, resulting in a lot of good feedback on what was wrong. We went back to work on data analysis and input that information into a timeline from which new missions were generated. Software development continued. New software requirements were generated by reenactment problems and new data about the battle. As the software improved and more information became available, the simulation was repeated. We go through a cycle of simulation, reviewing the results, adjusting the simulation, and then repeating the simulation. That has brought us to the point which we are at today. We have presented our third reenactment of the battle. This is still work in progress and we still have many cycles to go. Both new data and the results of the reenactment will probably cause changes

in the timelines. We find two new processes starting at this time, verification and special effects. Verification is needed in two places. First, we must verify that the timeline data is consistent with the source data. Second, we must verify that the simulation data, the reenactment, is consistent with the timeline data. The addition of special effects will enhance the realism of the presentation.

SLIDE 8. REENACTMENT SYSTEM
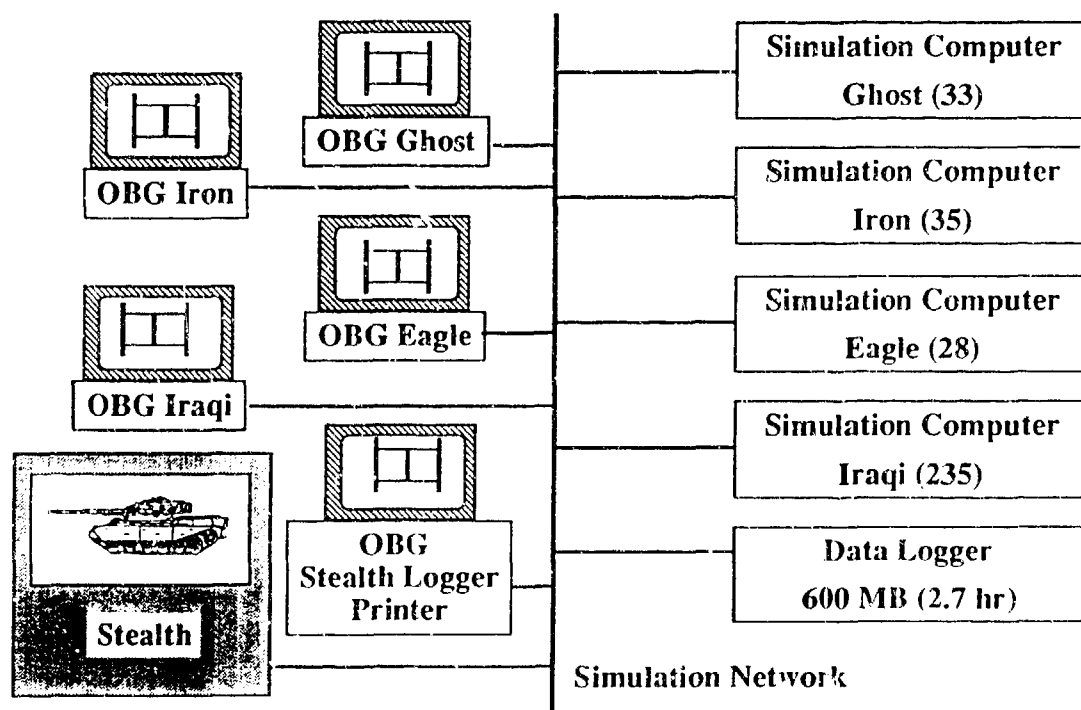
Slide 8. This is the configuration of the ODIN system which was used to produce the reenactment. We used five OBGs, four SAF simulation hosts (SAFsims), a data logger, and a stealth. Except for the stealth, all these systems run on MIPS RISC computers. We paired off the OBGs with the SAFsims. The top pair was used to simulate Ghost Troop. We had 33 vehicles in that troop. A few vehicles are missing from the trains right now and will be added in the future. Similarly, we used two pairs to simulate Iron and Eagle Troops. The fourth pair was used to simulate the entire Iraqi force. We were able to simulate so many vehicles on one computer because the Iraqi forces were dug in and

static. The Iraqi force still needs to be augmented with a lot of dismounted infantry. As we add in more dismounted infantry, we will have to add in another pair to simulate them. The data logger tape that we produced from this two and three quarter hour reenactment contained 600 MB of data.

SLIDE 9. TIMELINES

Simulation Initialization

 • Automate Simulation Initialization from Timeline
 • Automate Mission Creation from Timeline

Timeline Editing

 • Make it Easier To Rearrange Data

Verification

 • Generate Tables and Overlays for Comparison to Source Data
 • Automate Comparison

Slide 9. This project is not only capturing what happened in 73 Easting, but it's also driving reenactment technology. As Gary comes to me and says, "We need to be able to do this," I say, "Oh no," and the developers set to work trying to put together the right type of technology to support the effort. The reenactment is driving the software development. Here are some examples of the the types of software which we have had to develop. Once we got the data into the ODIN timelines, it was a natural thing to take the timelines and automatically generate the initialization conditions and missions for the simulation. We haven't completely automated the process, but we have made some progress. We are able to take any scene on the timeline and use that as an initial condition for the simulation. We can also generate the routes and speeds to interpolate between the points in the timelines. There's a bit of problem with this process currently because the speed calculation doesn't take into account that the vehicles are trying to keep formation. The formations aren't exactly replicated and we have to go in by hand and modify them. We are working on extending the degree to which we can go directly from the timeline to initialization conditions and missions. As we were putting the data into the timeline, we found out that we needed a few more features to make it easier to change it. Each time the analysts look at the timeline, they want to make refinements. We've added the capability for inserting new time frames in between previous ones and the ability to change the times

of the old time frames. We've also developed software to support verification. The timeline is a data base of information about events in the battle and we can generate tabular summaries from it which can be compared to the original data. We are also looking into methods which we can use to automatically compare the timeline data to the reenacted data.

SLIDE 10. NEW SIMULATIONS

Dismounted Infantry
Cavalry Troops
Friendly Vehicles
- M113, M577, FISTV, Mortar, Ambulance, HMMWV, SP Howitzer

Enemy Vehicles
- MTLB, T 55, T 62, Towed Howitzer, Truck, Refueler

Logistics Sites
Artillery Scripts and Minefields
Required Changes
- 3D Models, 2D Icons, Dynamics, Weapons, Damage, Echelons Behavior, Protocol

Slide 10. It rapidly became obvious that ODIN didn't have all the actors that existed in the battle. We were missing dismounted infantry. We didn't have the organizational structure of the cavalry troops. A lot of friendly vehicles were missing, some of which were in ODIN but were not available as moving models in SAF. We have already added the M113, M557, and the mortars. The remainder of the missing friendly vehicles were mostly in the trains of the cavalry troops. There are also several enemy vehicles that we need to add. The battle also includes the blowing up of fuel and ammo sites as the troops moved across the battlefield. We need to add dynamic models of logistic sites which blow up when they get fired upon. To replicate the effect of artillery coming in from outside the battlefield data base, we implemented artillery scripts. We also added minefields to the SAF, to show the effect on the tanks driving over them. The minefields were not used in this particular version of the reenactment, but the software is ready and as soon as we become a little more confident with it, we will start using it.

I'd like to go over what it takes to add new models, such as new vehicles and units, to the system. First, you need a three-dimensional icon which shows what the vehicle looks like in the real world. It's really a whole family of icons with different icons for each state of the vehicle, for example, normal or damaged, and for each level of detail it will be shown at. Then we have two-dimensional icons that are used to show the vehicles on the two-dimensional map displays. You have to add in the dynamics for the vehicle, the types of weapons it has, its damage probability tables, and the echelons that it's organized in. You have add the behavioral responses that the vehicle is supposed to perform when given a command. Knowledge of the new vehicle has to be added to the protocol so that all the systems listening to the network will know what kind of vehicle they are hearing about when they receive a packet from it .

SLIDE 11. CONTROL

Reenactment Requires

  - More Precise Control
    - Shooting
    - Movement
  - Better Synchronization
  - More Programmability

Use Highest Level of Control Possible

  - Precluded in Well Defined Situations
  - Fewer Instructions

Slide 11. We really had to increase the level of control that we had over the SAF vehicles. We couldn't allow their built-in behaviors and decision making models to operate because we had completely specified situations. We had to augment the SAF command set with very specific repeatable commands.

Slide 11A. The menu shown in this slide is used to enter shot requests. You can place a control point with a shot request on a vehicle's route. In the shot request, you select the weapon to use, the location or vehicle to shoot at, a delay time before the shot is fired, whether it's supposed to hit or miss the target, and the resulting damage. Each control point can have multiple shot requests on it.

SLIDE 11A

Slide 11B. In order to control movement more effectively, we've gone away from giving commands at the unit level and are giving individual vehicle routes throughout most of the simulation. What you see in this slide are the routes for the Eagle Troop tanks. The red line here is McMaster's route through the battlefield.

BLOEDORN: Those routes are not simple extrapolation. Those are the routes the individual vehicle commanders told us they took through those areas.

Q: What is left of the simulation given that deterministic weighting?

A: Well there are some places, as I'm going to get to in a minute, where the information that you have is not 100 percent complete. In these places you do have to do some interpolation, but what's left is limited.

Q: Are the train vehicles still in the simulation or are they deterministic also?

A: They are also deterministic, but they're being commanded as a unit instead of by individual vehicles.

In order to be able to synchronize the vehicles, we've got lots of control points on each individual route. If we were doing a normal SAF exercise, we would use one control measure to control large numbers of vehicles. In order to be able to program in halts and changes in speed at particular times, we use offsets from H-hour. We also use them to synchronize the incoming artillery. There is a tremendous amount of data to be input. If there's a change which requires moving an entire unit, it causes considerable pain to move all the routes and control points. In the places in the simulation where the actions of the units are not completely specified, it is preferable to let the simulation decide how to interpolate. This reduces the number of commands which need to be changed as you go through the adjustment and reenactment cycle.

SLIDE 11B

SLIDE 12. SPECIAL EFFECTS

Environmental

- Sandstorm, Haze
- Illumination Level

Weapons Effects

- Hull/Turret Separation
- Tracers
- Fire, Impact, and Explosion Effects
- Wind Blown Smoke

Sounds

Special Effects Impact All Systems

Event → Packet → CIG Controller → CIG

Slide 12. We are adding a number of special effects to the simulation. We want to be able to show the sandstorm, the haze, the illumination, and the visibility. It will be possible to turn these effects on and off, so that you can show what it looked like to the troops and then show what was really there. In addition, we want to show more realistic weapons effects. The hull/turret separation of the T72 is very important for illustrating the effectiveness of the American ammunition. We also plan to show tracers and more realistic explosion effects. To show the strong wind blowing during the battle, we will slant the smoke columns in the direction of the wind. In addition to these visual weapons effects, we have to add the corresponding sound effects. We also need to insert and synchronize the command tape from Eagle Troop. This will probably result in the adjustment of some of the events in the simulation to match those events on the tape.

You might think that these changes only affect the CIG and the sound system, but in reality everything is affected. The special effects are initiated by events that happen on the battlefield. These events have to be generated by either the OBG or the SAF which produce packets representing the events. These could be modifications of current packets, or they could be entirely new packets to represent things like the illumination level and the strength of the sandstorm. For presentation, the packets have to be interpreted by the flying carpet CIG controller which translates each event into a series of commands to make the CIG and sound system produce the desired effects for the viewer.

SLIDE 13. RECORDING AND PRESENTATION

Data Logger

- Compression
- Freeze Frame

Flying Carpet

- Object Density

Slide 13. We need to make improvements to the data logger to support the recording and presentation of this reenactment. As I mentioned before, we produced 600 MB of data for about half the battle with many of the secondary vehicles not included. Instead of adding lots of gigabyte disks to the data logger, we feel that it's entirely feasible to compress the data prior to putting it on the disk and uncompressing it as it comes back off. That should enable us to record the entire battle in the 600 MB that we used for this reenactment or even less. In addition, we would like to be able to freeze the playback at a certain point with all the vehicles remaining displayed. The ODIN flying carpet will timeout vehicles which stop broadcasting their appearances on the network, causing them to disappear off the screen. By changing the data logger to rebroadcast packets when it is paused, you could stop at any point in the simulation and fly around and examine it from many different angles.

In the flying carpet, as I've mentioned before, there's a limit on the number of objects which can be presented. If there are too many vehicles in view not all of them can be painted. Right now, we're using a simple algorithm to protect the CIG from overloading. Once the number of vehicles in the vicinity of the flying carpet exceeds a limit, the CIG is not told about any more. We need to refine that algorithm to count only those vehicles that are actually in the field of view of the flying carpet and make use of the full power of the CIG.

SLIDE 14. REMAINING REENACTMENT EFFORT

Missing Elements

- Remainder of Iron Mission
- Red Counter Attacks
- Unshot Iraqi Vehicles
- Aviation
- Iraqi Target Firing Pairs
- Dismounted Infantry
- Supply and Storage Facilities

New Data

- New Database
- Feedback
- Synchronization with Audio

Verification and Adjustment

Slide 14. Let's reiterate the things that need to be done to complete the reenactment. We need to put in the remainder of the Iron mission, which should be happening up in Cambridge as we speak. A red counterattack that occurred later in the battle with Ghost Troop needs to be added. The target firing pairs need to be straightened out so all of the vehicles that were actually shot in the battle get shot. There's some aviation activity that occurred in the battle that is not in the reenactment yet. We don't have any information in the reenactment about the target firing pairs for the Iraqis. The analysts have that information and it will be added to the reenactment. As was mentioned before, dismounted infantry and supply and storage facilities are being added. We are going to get new and more accurate data. A new terrain data base is going to be released in the mid-September time frame and we'll see how our reenactment fits in with it. The data analysts are seeing the latest reenactment here for the first time, so I'm sure we're going to get a lot of feedback on it, especially through the verification process. In addition, the audio track that v have is going to let us synchronize our events much more accurately with the real world.

SLIDE 15. FUTURE DIRECTIONS

Quicker and More Efficient Reenactment

Training Presentations

- View Battle from Vehicles
- Refight Battle with New Tactics

Integrate Data Collection, Analysis, Simulation, and Presentation

- Capture Data in Timelines
- Simulate to \ rify Plausibility
- Present to Elicit Feedback
- Portable Hardware
- Audit Trail

Slide 15.   In the future, the technology that we're developing with the ODIN timelines and simulation should result in much quicker and more efficient reenactments of other battles. Besides showing this reenactment to soldiers from a stealth viewpoint or a plan view display viewpoint, it is also possible to modify a simulator so it could be assigned to one of the vehicles in the reenactment and would automatically reproduce the actions of that vehicle. Then you could actually put soldiers in simulators and let them watch the battle through the viewports of a vehicle in the battle. Once they have done that and are familiar with the battle, you could ask them to refight the battle their way. You would reinitialize all the semi-automated forces and manned simulators at some point in the battle and let them continue the fight from there. However, to do this we cannot continue to use extremely low level commands to control the SAF vehicles. We have to evolve those commands into more abstract higher level commands for units which give the intent of the battle instead of commanding specific events to occur. The men in the simulators may decide to drive to different points and the SAF shot requests will not find them in the expected locations. We already have more abstract command representations in the SAF that we can use to accomplish this.

An important thing we would like to do is to speed up the information flow between data collection, analysis, and simulation and close up the feedback loops. What you really want to have is a portable ODIN system, such as the truck or, even better, a suitcase size system that a historian can take out to the battlefield with him. He could directly enter in the information as he listens to the battle participants. He could use a scanner to capture the graphics that they've used, if the graphics aren't already in electronic format. He would automatically have an audit trail for each piece of information that's obtained. Then all the information could be examined via timelines and simulation to verify the plausibility of the events and their sequencing. The results would be shown to the battle participants, to help them figure out what actually happened. That is the direction in which we should go in order to help capture history in the future.

BLOEDORN: We can entertain questions now for Andy, Jim or myself, anyone you would like to direct it to.

Q: I have a question for you, Gary. I'll probably add another confusion factor to an already confused situation. You mentioned some discrepancies remain unresolved and that because some of the vehicles had GPS you knew exactly where they were. Were you aware of the fact that small, lightweight GPS receivers being used probably had random errors in those positions of about 150 meters?

A: (BLOEDORN) No, sir, I was not. They were giving me the data in 10-digit coordinates and I was not aware that they could have that much error. Thank you.

Q: The small, lightweight units used under ideal conditions might get 15 meter accuracy but under the conditions they had over there for the most part it was worse. You might in fact be creating some problems by insisting the GPS data was exactly correct.

A: Yes, thank you. The issue again, as I emphasized over and over, is the cross-referencing of data. What I come out with are events that are consistent with all the known data and that are not contravened when we place them in Andy's simulation and timelines and on the terrain. Jim made the statement that he takes his tapes and the GPSs as ground truth because our impression from our interviews was that those people with GPS were probably more accurate than those without GPS. Obviously, since I was not aware of the random errors of which you speak, I couldn't isolate it any further than that.

Q: There were several versions of GPS receivers in use in the desert which were certainly good enough. If you need to know where you are in the middle of a desert, knowing to 100 meters is certainly adequate.

A: Again, keep in mind that I used that kind of data plus actual survey data on all the targets from the corps engineer battalion and the battle reconstruction center to put my targets down. We looked at lines of sight, photographs of the areas, the firing positions, the relative positions of where they shot from and where they hit, photographic data, as well as interview data. So the GPS, although an important point, I emphasize, was not the only point.

Q: To Dr. Ceranowicz - Are you suggesting that we could take ODIN out to Fort Irwin and write an interface that would allow us to take information off the range data measurement system about position and firing events and automatically load them up as timelines into the system?

A: Yes, that's exactly what I was indicating and that's one of the applications that came to mind when I was putting this talk together.

Q: So that would allow us to build 3-D after action reviews in the NTC. If I have a PVD work station, I could actually recreate and observe key events in the battle?

A: Yes, that's certainly possible, especially with the amount of data that you have from the NTC.

Q: One of the basic steps in building a data base is to get a grid of elevation data. What are the polygon sizes for this data base that's being developed. In other words, we're worried about 100-meter errors in position here for locations. Are the polygon sizes now below 100 meters on your basic terrain grids?

LUKES: I'm not sure I got the full question?

Q: Basically my question is now we're worried about positioning things within GPS system accuracy. I've heard 100 meters today and a basic design of a simulation data base generally does not have polygon sizes that small except for models of trees and other things that are of that size. Now in a data base where you've got flat level terrain like this you certainly don't have 100-meter polygon size as your grid with your texture on top of it. Don't you have more like 1000-meter polygons on the side or 500-meter polygons?

A: We do have undulations in the surface. Asking whether it's 500 meter or kilometer polygons is inappropriate. We've seen areas where during portions of the battle intervisibility was obscured, the reverse slope, and so on. As we indicated, the surface is being built largely out of 125-meter triangles. The relative location of the objects on that

surface, however, is the key action. What we're talking about is a platoon of tanks and so on, the adjacent elements, you've got a grain of resolution that is much less.

Q. I guess my point is that because of the limited processing power of the particular machines being used in these types of simulations we are almost looking at things that are beyond the capability these machines.

A. My initial reaction is that we're looking at both space and time and the relative position of these objects sitting on top of that surface. The grid size is but one factor and not the critical one. The question to me is whether the terrain is varying in such such a way that we get an adequate representation of the terrain on which the action can take place. Have we built an adequate stage? For the most part the evidence being generated says yes.

We are certainly helped out by the fact that the terrain is flat. If it had been a really rough irregular terrain then we would have needed a lot of resolution in order to depict it.

Q. When you went back to reinterview the troops, what were the types of errors that the simulation helped catch in terms of position or defense?

A. All of the above. We had our misunderstandings, they gave us the wrong information when it was midnight and they were just coming back from cleaning a tank, or they gave us information for a member of the crew that was missing while we were in country because he was off in an aid station or he was punching a gun tube. The real gut issue was, and we failed to tell you, that their stories didn't jibe with each other. Coming back with the simulation, forced coordination both within each troop and between the troops. We had a follow-up interview where I got certain individuals in the same room together, told them what the problems were, and worked them out. Some they categorically denied...that's not where the village is...that's not where he was...he did not shoot at those targets. But we got them all in the same room together and showed them the data, and let them discuss it and draw it out, then they came up with a unified "gee, I didn't know that" or "boy, that's really interesting." It is the simulation's function to provide the context and timing and it allowed us to get them back on a level playing field with time to analyze their own actions and impressions. And it proved invaluable for us.

Q. I'm a little curious about the position you took when you talked about running the SAF and taking control away from the simulation in order to institute an approximation of reality based on the input data. Doesn't that suggest that maybe you're rigidly scripting a scenario sequence just to use Odin to produce a graphic display rather than calibrating your model to do what the object in simulation should do in order to replicate reality? And

the other question is, doesn't that position then restrict your ability to play what if games in the future?

A: Because the data we have completely specifies many events, we have to restrict the capability for independent SAF action. If I were to use the existing SAF control models, no matter how I tuned the models to get them, on the average, to reproduce the actual behavior, it would still be statistical and we want to reproduce history repeatably.

Q: You don't use deterministic algorithms?

A: No, there's random behavior in people. We can't take a person and put him back in time with exactly the same initial positions and verify that he'll do something different. But my feeling is that there is a good chance that what he'll do will not exactly repeat history. That randomness is reflected in the SAF algorithms that the vehicles use. Now as far as being able to use this system for graduate level time travel, you're right, having those very constrained definitions of what the vehicles are supposed to do, so that they will exactly reenact history, does not allow them to go and fight a similar but different battle. What we have to do, is to take the missions that we have prepared and abstract from them general purpose missions which do exactly what you say. On the average, it will recreate what happened in the battlefield but it's not so specific that if a target doesn't show up exactly where and when the script says it's supposed to be, it won't be fired at. With higher level control they'll have the freedom to decide what to do. But you have to accommodate both the repeatable reproduction of history and higher level commands allow SAF to react when that history changes.

A classic example of that is the troops themselves. We couldn't put them in the simulators at the SIMNET site and have them fight this over again. We just couldn't do it. They wouldn't have replicated what they did on the battlefield. We ourselves couldn't do that again. That would be totally non-historical if they did it again.

Q: Is the history so critical here because you're really trying to understand on average what would happen there, you could have one sample with some really green soldiers, maybe you'd like an ensemble like that?

A: Of course, we would, I agree. I could not agree more. That's when we get to the graduate level time travel.

Q: It seems like you're trying to polish the simulation here to replicate THE battle as well as you can and it may be totally academic.

A: It may well be academic, and that's the nature of the program. It is an experimental program. We're learning not only how to do it and how to apply the technology, but we're also going to learn as we do it, what are the utilities, the difficulties, and the conundrums. The problem that I'm faced with is that I don't know *a priori* until I put it together what is critical and what I could have dropped out. So I'm in the business now, when we go into the analytical process, of making judgmental decisions about how critical this is and the appropriate level of abstraction. You know, when I try to recreate history with people, errors are going to creep in, so I don't want to produce gratuitous errors when I have an experimental program. Does that make sense?

Q: Unlike the desert, the terrain in Germany is much more complex and you look at miles of tree lines and hills. In a field exercise there, the detail of how those tree lines are used is absolutely critical to the outcome of the exercise and that's a level of detail that you didn't have to worry about in the desert.

A: On the contrary, here the rise of one and two meters became absolutely critical to life and death, as COL Krause pointed out in his opening sentence. That was one of the toughest lessons to learn in this desert. We get down to the absolute micro level. Sgt. Molar died because his vehicle was about 12 feet too far forward. No one else in the platoon, which was 12 feet back, received that fire. But they were still able to deliver and kill. Literally 12 feet made the difference and so when I'm faced with that kind of concrete evidence, I'm trying to get as close to ground truth as I can. Because, in the desert, it is very critical. I think any soldiers here that maneuvered in the NTC or in the desert would agree with me. It is really critical.

Q: I noticed on one of those charts that it indicated you expected to have the reenactment done by the end of October. If I understand correctly, the reenactment will have been checked out and verified.

A: Yes sir, that's right. You got it.

Q: What is your expectation of learning the process to go into the real training version where individual soldiers given the same types of orders can refight a battle like this but not necessarily with this particular outcome?

A: Conceptually only, all right? Andy mentioned that they can write the software to make any given point in the battle become the initialization for forces that are manned or semi-automated or mixed. Once we switch into the random, AI based, or what we call combat instruction based, semi-automated forces or the manned simulators, we only use

the simulation to control the the initialization of the fight. Now that everything is close to the way they were when McMaster was there, we can say, "Lieutenant, you are there." So for an instructional way to teach history, to first show them the battle and the outcome, and then put them in there, after they've made their own individual assessment, to see if they can better that, I think that's fairly straightforward.

We would take the initialization information and capture it in an overlay. The modified intialization software in the simulators and in the semi-automated forces would use the overlay to recreate all the vehicles in their initial positions. The vehicles would be initialized not only with their positions but with what they were doing at that point in the battle and their missions. Then you'd start them off and the battle would evolve.

BLOEDORN: What you have to understand is...

Q: I still don't understand what you said. Is it a matter of minutes, hours, days, weeks...

BLOEDORN: It would only take minutes to go from presenting the battle to refighting it.

Q: (cont)...from the time you run the engagement to the time a soldier could sit down and improvise and play it back?

A: Oh, you're asking, how long is it going to take us to develop the graduate time travel system?

BLOEDORN: No.

Q: Exactly.

BLOEDORN: No, are you asking the question of how long is it when I turn on the switch? Yes, it is a matter of turning on the switch.

Q: I also wanted to know how long it's going to take to go the next step.

A: Our program development calls for the spring of '92. That depends on the funding profile and if they run into any technical issues.

THORPE: The answer is, we don't know, sir.

Q: Are there technology issues involved in going from the level you're at right now to any higher level of application...

A: I think what you're referring to is the point when I said that there wasn't enough information in the simulation to portray/present what happened at the squadron and regimental level. And that's simply because we have no information in the system about what the other troops in the regiment or in the squadron were doing. So therefore, we cannot draw a little unit symbol at the position where that unit was throughout the battle. That's what precludes us from doing that.

BLOEDORN: And he doesn't have it because I wasn't allowed to get it when my project was over there.

Q: Are there any technology issues precluding you from taking the next step.

A: There will certainly be some software development that's involved and there will probably be some surprises involved but I don't see anything that precludes us from going forward. There is no big issue that is standing up and saying "You can't do this."

Q: Are there particular items, the processing power, parallel networking involved technology...

A: Once we've presented this battle in one case, it can be presented in the context of soldiers and simulators.

THORPE: In my opinion, I think it's a little bit questionable. The reason is that you now have to have what we call semi-automated forces in simulation to take over at that point in the action. You bring the young student up to some point, then you say "O.K., kid, you got it," and at that point the simulation has to take over and allow him to put his will in there and control the rest of the battle. It also means whoever he was fighting against has to react in the same sort of way. We can kind of capture what the Iraqis did but we don't have any semi-automated forces that are Iraqi's. We don't know what was in their mind, we're learning. We don't know what their philosophy of warfare is and whether the Republican Guards are different than the 12th armored division. We have guesses, but we have no code for that. There's a lot of work to be done. Next summer we're not going to have a meeting where this stuff is all done. A lot of you guys have to do this work and I consider what we're talking about here has just started to scratch the surface. The baby is just getting born, and has got a lot of growing to do and you all become the godfathers, O.K., and so that's my own view of it and someone has to pay for it.

BLOEDORN: That's the work.

--73 EASTiNG--

WORKING SESSION

ODIN

28 August 1991

WORKING SESSION

LCDR DENNIS MCBRIDE (DARPA) - PROJECT ODIN

I intend to discuss as informally as possible with you for the next period of time our project ODIN, demonstrate interactively some of the capabilities of ODIN, field some questions, and also solicit ideas and opinions for the future of project ODIN. In the orchestra pit down below we have Chris Turrell who is an IDA employee and has been supporting the ODIN project. He is technically, administratively, and in terms of understanding the combat use, very helpful to us. We have utilized the technology in a number of domains around the country and Chris was always there supporting us, demonstrating and providing the assistance that DARPA needs.

SLIDE 1

PROJECT ODIN

First about the title, Project ODIN (Slide 1). Does anyone have any idea where we came up with this name? ODIN is a Norse God who has one incredible position description--he is god of wisdom, poetry, you name it. In his regard of the battlefield, he had two interesting helpers--they were ravens, one perched on each shoulder. One named Hugin and one Munin. One raven was responsible for memory, the other for thought. The way the system worked is that at night the two ravens would overfly the battlefield and the raven responsible for memory would indicate the disposition of forces. And the raven responsible for thought would interpret what it all meant. ODIN was able to keep up with this complex environment by reconnoitering without getting shot. It appeared to me in August of 91 that the technology I was trying to develop was going to do the same sort of thing for CENTCOM. To elaborate further, ODIN, the god, in order to gain wisdom, sought to drink from the well of wisdom. He was allowed to do so only after sacrificing

one eye. He gladly did that. His sacrifice was to gain a lot of insight by losing some resolution, if you will, losing part of his vision. And there you have it--Project ODIN. It's also the case that we just had to name it and the last fiction in the last mythology that I went through after going through American Indians and everything else was Norse and this one really appealed to me. And I think it's really right on target.

SLIDE 2

ODIN

HOW CAN WE FUSE <u>PROVEN</u> TECHNOLOGIES TO PRODUCE AND FIELD AN ENSEMBLE THAT WOULD BE USEFUL?

(ASSUME THAT THERE IS RISK IN THE CONJUNCTION)

TECHNICALLY A MATTER OF EXPLOITATION . . .

Next slide. The idea the first week of August, was how can we at DARPA fuse proven technology to produce and field something that would be useful to the Services and, in particular, to the CINC. It's important that I point out here that the idea was to reduce risk because, if we were actually going to be useful, it had to work. Therefore, we needed to take proven entities, fuse them together to produce a synergistic held that somebody had not done before. Something that would really pay off. The risk was in the conjunction-- putting these things together. Can we really make them work? So this is technically a matter of exploitation; getting the best out of something, putting it together, and producing a collage of the parts--none of which knew what they would ultimately be used for.

SLIDE 3

Composite DARPA Technologies

- **TACNAT (TACtical Use of NATional and Theatre Technical (Means))**
  - **Enemy Behavior Monitoring**

- **FULCRUM (Laser Video Based, Electronic Map Case With Selectable Perspectives)**
  - **Target Development**

- **Flying Carpet (Free Fly, Space/Time Travel)**
  - **2-, 3-, 4-D Representation**

- **MACSAT (Satellite Based Store-and-Forward Data Relay Systems)**
  - **Intra/Inter-Theatre Messaging to Remote, Mobile Odin**

- **Rapid Database Management (Object Oriented Terrain Generation and Graphics Management)**
  - **"Point 'n Shoot" Manipulation of Flying Carpet Database**

Next slide. The idea then and now was to exploit state-of-the-art digital terrain data base representation to include (but not limited to) DMA data, spot imagery data, or anywhere we could get good data. This includes intelligence, HUMINT about terrain in the theater of operations, and the ability to teleport ourselves through space and time so that we could actually take a look, like Hugin and Munin, at this battlefield and understand it by using our two eyes. Third, utilize an object-oriented environment so that when we place objects on the battlefield, they in fact are objects, and they can be manipulated as objects, and ultimately they could move and they could behave. Then we could utilize our semi-automated forces technology in order to drive them and interact on a playing field when we get there. We wanted to be able to show the battlefield in two, three, and four dimensions. That is, 2-D as you've seen the plan view display on the middle medium, the 3-D is the out the window. By putting your hand on a manipulandum or "spaceball," you can move yourself anywhere in space and time and take a view of a battlefield. The fourth dimension, obviously, is that of time. We also wanted to make the fourth dimension come alive by utilizing something that we had never done before--to instrument control measures, notations, or a sketch pad on the 2-D display and also on the 3-D display. If a commander

at his keyboard, and our idea is that John Madden, writes with a stylus on his keyboard in front of him a control measure, it should show up on the 3-D display and should be remembered in 2-D. There should be features that keep them corrected and store them. Also, the time element should be important and displayed such that you should be able to go back 10 days in your terrain or your order of battle data base and ask what the military picture was 10 days ago at the division level, only armor. Presto-changeo, instantly it's there. Now nine days ago; eight days ago, seven; now give me tracks; show me the progression of these tanks over time so I can get a picture at day 0 of what I think my enemy commander is up to; now overlay artillery; now put friendly forces on; now I'm getting sort of cluttered so let's declutter and kick it up to a higher level. That was the basic idea to use those existing technologies and put them together with two other very important ones that another program manager at DARPA is responsible for fielding. The other two are TACNAT and FULCRUM. I'll talk about those briefly, in just a moment. The idea of those two technologies is to bring an automated order of battle generation system into my environment so that I can display real time order of battle best we can get it and, of course, since it's intelligence, it's sensitive. Therefore, we had a design issue there that I'll get into.

Last of all, and here I've listed SABRE while going through a number of bullets, is the idea is the fast future. Spying. You've got the past that you can see, with some level of precision, disposition of forces with a lot of notation on what's been happening over the past several days or hours. Wouldn't you like to fast game that out? What does it mean? The idea is to apply a given wargaming technology or fast forward technique that would allow a commander to ask, is my enemy trying to come around my left flank? Responding, the machinery would do a lot of calculations and perhaps reply, he may be trying to come around your left flank but, if he does, he is seriously exposed on his central front. The commander can ask, why is that? Give me some numbers. To interactively iterate with this computer machinery is to understand and command the world in front of you.

WHY NOT BRING MAP/CHART TECHNOLOGY INTO THE 20TH CENTURY?

This technology will allow CDRs to "step inside" a tactically relevant 3-D world in order to:

- **Improve *mental-mastery* of the 3-D Area of Operations**

- ***Communicate* with other CDRs and subordinates more effectively in building *mission concepts* and *plans***

- **Develop 2-D "unfolds" of tactical events/histories of *force movements* and *"what if"* pictures of the future**

Next chart. Our idea was to enable a commander to get a mental mastery of this 3-D area of operations. An environment where a commander can bring subordinates in and he can convey his intent with absolute clarity. And, in fact, he could bring a man or a woman in, who spoke a different language, and convey his intent to him or her. You point to a phase line, you live it, you go turn around, you see what you look like to the enemy and understand this order of battle in three and four dimension. And then, finally, to develop these, unfolds the ability to fast forward, to stimulate our thinking about the future.

Mission:

- Design
- Develop
- → Determine Users *
- Demonstrate
- Develop
- Deploy
- Disposition

* The Hardest Chore

Next slide. In our evolution, the first challenge of course was to design this system from the top level and then begin inventing the interfaces that were required to operationalize. The development process was actually putting them together and making things talk to each other to our behavioral specifications. Next, a very, very important matter--a determination of who is going to use this thing. It just turns out that early in our evolution, the science advisor from CENTCOM visited, and we briefed him on the concept and showed him an early prototype. I told him that we had in mind an Air Force TACC as the target user of this equipment. He said, "Nope." This is a CENTCOM war room device and very soon after a letter of compelling and urgent need found itself leaving central command and coming to DARPA and identifying CDIN as a third critical technology requested for the war. The issue of determining the user dominated this entire evolution. Not technology, but the determination of a user. I'm going to get back to that in the next slide or two. Next was to demonstrate. Let's get commanders and man up, let's show how it works, let's get your feedback and understand where we're going wrong and what we need to know to fix it to make it help you. Then to deploy. Initially to deploy here in CONUS in "safe simulation," as we call it. Get it hardened, robust, and then field it into the theater of operations and use it. And then finally what's the disposition of this technology, what are we going to do? Do we give the literal configuration to someone, do we retain it, do we give the services the blueprint, or just what do we do?

SUMMARY REPRESENTATION OF PHYSICAL SURROUND

O-1   O-10
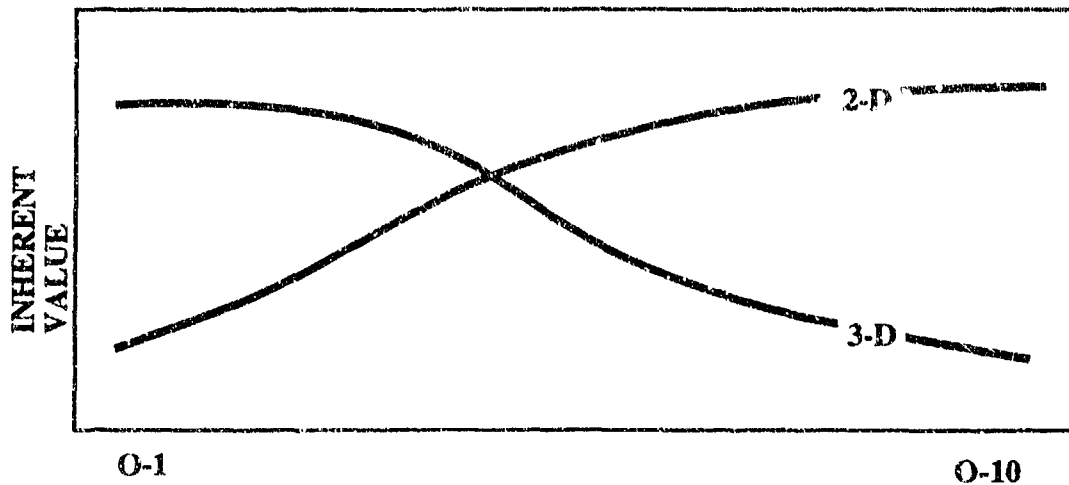
Next slide. Here's the design problem that I introduced before. It appeared to me that as your focus goes from left to right on the abscissa, the value of 2-D and 3-D technology changes as a function of command level. In other words, an E-1 with a rifle and a bayonet is not very concerned about a large theater of operations and a large 2-D map. He's worried about the area right around him, protecting himself, and eliminating threats around him. On the other hand, a CINC is not very concerned about the area right around him, that is a tactical decision environment; rather, he's very concerned about a very large expanse. If he can see 3-D, he's already too fine grained. He can't make decisions strategically by looking at the tactical picture, except in some cases involving special ops. So what's the real shape of these curves?

SUMMARY REPRESENTATION OF PHYSICAL SURROUND

O-1   O-10

USAF   TACC

USA   BnTOC

USN   TFCIC

$$\Sigma = MAX$$

II-107
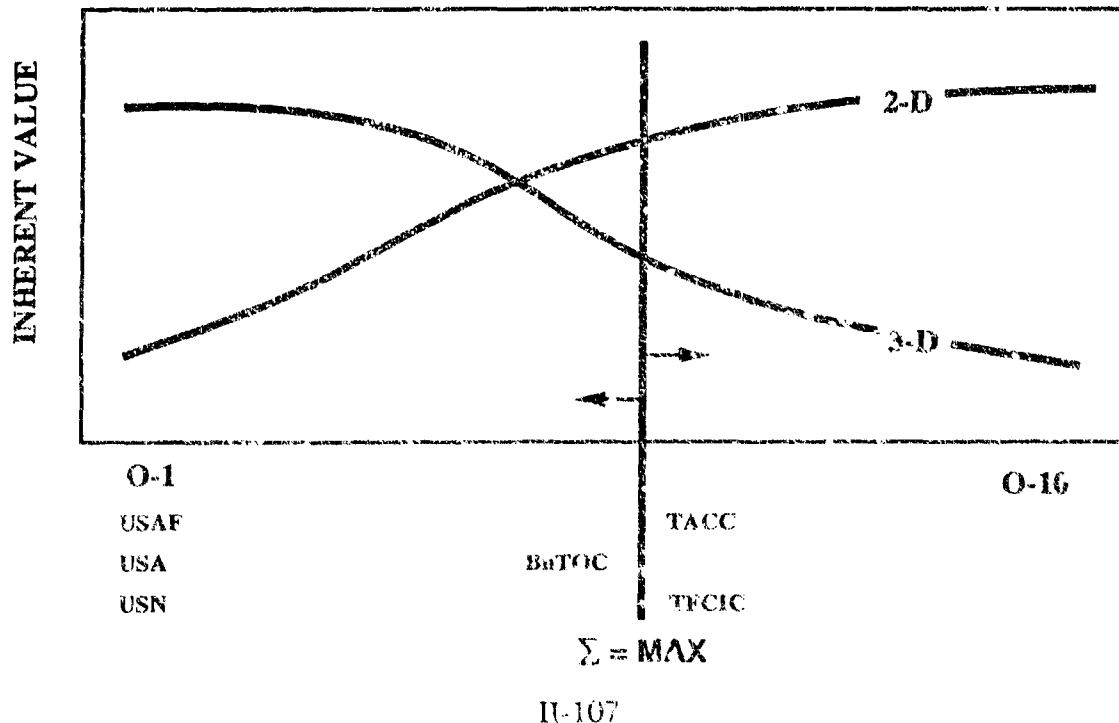
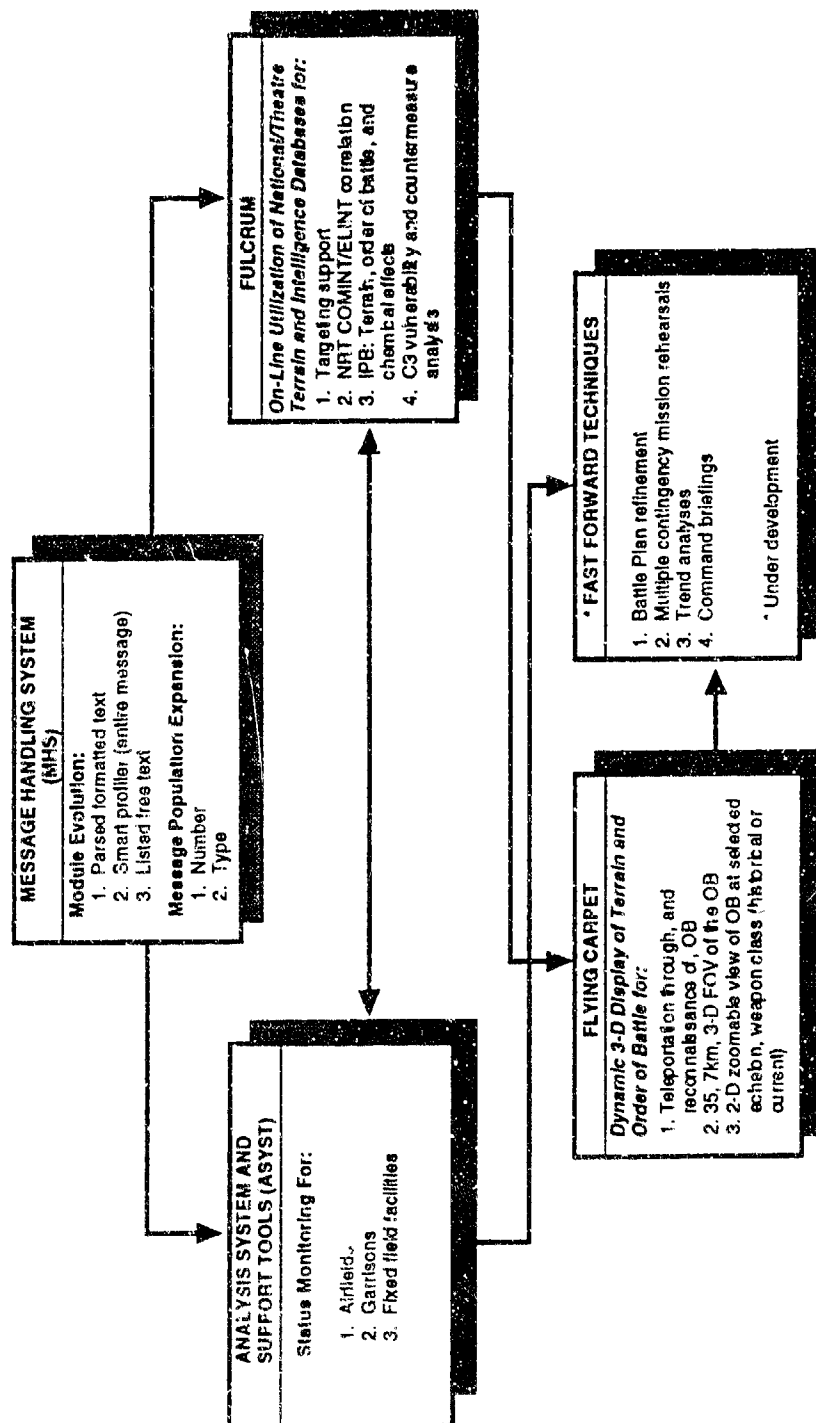Next slide. Maybe they look something like this and it depends on what Service and what general application you're using. But I wanted to adjust this particular cutting line to the left and to the right until I maximized the summation of those two curves. This was very, very hard to do. I told you that I began with an Air Force TACC because it really seemed, coming from brown shoe Navy myself, that this is an aviation application. Well, we tested and continued to test our idea in a number of places and, fortunately, our problem is that for the most part, everyone we've tried it out with wants to keep it there and not let us take it to the next idea or the next branch and test it at their location. What we ended up doing, as you see in the next slide and as you're experiencing right this moment, is we said alright everybody wins. We are going to have at least three renditions, three configurations, the first of which is self-contained in this van complete with power generator, and driver when we need it, and a full-time professional, Chris Turrell. We have positioned this ensemble in a number of locations, principally for test, at Fort Knox at the Armor School, where we got, early on in a pre-alpha test, a lot of very interesting feedback, most of which said you've got to harden it, you've got to make this thing robust before you take it to the desert. In fact, one of the strongest ideas from Fort Knox was that this has a compelling aviation interest, and it ought to go to Fort Rucker for tests. So we take the truck to Fort Rucker and that has sort of been its home away from home since then. Excursions have included conferences like this one, UAV conference and a number of others. Each time we go, Chris comes up with a list of 50 new good ideas. I hope at this occasion, we'll get 50 more new good ideas. The second configuration is at the Army's Engineering Topographical Laboratories here at Ft. Belvoir. George Lukes is the program manager there and Colonel Maune heads up that organization. We're utilizing their secure facilities as our skunk works to develop the basic technology. The third application goes to the CENTCOM war room in CONUS at Tampa. Given a lot of contingencies, we have all of our preparation done and we're in a staging area ready to go in.

Next slide. The overall top level design looks something like this. Information flows roughly as these arrows indicate. You begin with a message handling system. The idea here to take into consideration is that, technically in a machine, there are lots and lots of military messages to be handled to extract meaning from them so that ultimately they can be used in a non-classified mode. That output goes two places, TACNAT (tactical use of national assets) and FULCRUM. I'm going to give a little more detail on TACNAT and on FULCRUM in a few minutes. Basically, TACNAT is used for monitoring activity at air

ODIN

Information Flow Architecture

DARPA

MESSAGE HANDLING SYSTEM (MHS)

Module Evolution:
1. Parsed formatted text
2. Smart profiler (entire message)
3. Listed free text

Message Population Expansion:
1. Number
2. Type

ANALYSIS SYSTEM AND SUPPORT TOOLS (ASYST)

Status Monitoring For:
1. Airfields
2. Garrisons
3. Fixed field facilities

FULCRUM

On-Line Utilization of National/Theatre Terrain and Intelligence Databases for:
1. Targeting support
2. NRT COMINT/ELINT correlation
3. IPE: Terrain, order of battle, and chemical effects
4. C3 vulnerability and countermeasure analysis

FLYING CARPET

Dynamic 3-D Display of Terrain and Order of Battle for:
1. Teleportation through, and reconnaissance of, OB
2. 35, 7km, 3-D FOV of the OB
3. 2-D zoomable view of OB at selected echelon, weapon class (historical or current)

* FAST FORWARD TECHNIQUES
1. Battle Plan refinement
2. Multiple contingency mission rehearsals
3. Trend analyses
4. Command briefings

* Under development

fields, in garrison, and other environments. FULCRUM is used primarily for targeting support. It's a video laser based system that allows you to get a Jane's on-line and to get fairly real time information on order of battle and terrain. What you're looking at here is the flying carpet. So you've got all this information and the hard work done to produce your terrain to the highest quality that you can get it. Let's go take a look at it now. Let's teleport ourselves through the order of battle. Normally, a commander would be sitting a lot closer than you people are to this three screen device. It satisfies the human factors requirements a little better if you're sitting where you need to be, about 100-degree 7-kilometer 3-D field of view as well as a 2-D zoomable order of battle plan view display that you see on the central screen. Now the fourth dimension is added here so that on either screen the commander can select a day and a time in the past and take a look rather instantly, it's a matter of loading the data. Then, if we decide to do it, we take all of this information and to put it in some inferencing machine of some sort in order to understand what the future may hold for us. We've explored possibilities here and, with the help of the Air Force, we actually utilized the design of one of their efforts to understand how, in fact, we would port our order of battle into his system so that it would be initialized as the beginning of a war game. And that had very interesting prospects.

FULCRUM Provides:

Electronic ➡ Perspective ➡ Terrain, ➡ Force
Color Road Map   Imagery   Defense   Layouts
                                   Analysis

- Platforms
  - PC (DOS)
  - Sun (UNIX)
  - Macintosh (MacOS)

- Resource Database
  - Map Videodiscs, WVS, ADRG, WDB,VPPDB
  - DMA Digital Terrain Elevation Data (DTED)
  - DMA Gazetteers (Place Names for SWA)

- Database/Message Interfaces
  - CENTCOM GOB (AOB/EOB In Progress)
  - DIA IDB II
  - DIA AIF
  - Advanced Tracking Prototype (ATP)
  - PC-NIPS
  - TG
  - COINS

- Desert Shield Users (Partial)
  - USCENTCOM
  - USSOCOM
  - Navy (Carriers and Command/Control Ships)
  - DIA
  - NSA
  - Special Operations Units

- Other FULCRUM Users (Partial)
  - Korean Intelligence Support System (125)
  - Special Operations (50)
  - CINCPAC/IPAC (45)
  - USSOCOM (20)
  - Army Operations Center (25)
  - National Agencies (80)

- On-Going
  - JVIDS/JOTS/JOT-II Interface
  - Secondary Imagery Dissemination Interface

Next slide. A little more detail on FULCRUM. You can read for yourself there is a lot of information here. The technology is fairly understandable but the revolution is easy to miss. At one station you are able to pull up data in detail on a type of airplane, or a site in particular, in a theater of operations and put your thoughts together. An example I use involving TACNAT and FULCRUM is that TACNAT, by observing and inferencing from messages, makes the inference and shows a red Ali Al Salam airfield on your screen. The red means that I, the machine, am over my head; a human being needs to investigate this Ali Al Salam. The reason I, the machine, think so is because airfield activity has gone beyond some criterion that you, the human being, have set. The investigator then will say, yes, I'll click on you Ali Al Salam and find out what's going on and, sure enough, the activity at the airfield has satisfied some thresholds and I find out that maybe I have a responsibility to take out this airfield or do whatever it is that I need to do. But I, as an investigator, can go as deep as I want to, all the way into TACNAT, as far as I need to go, to understand that the machine has made the inference and a human now needs to look at Ali Al Salam. I would then turn to my FULCRUM station and investigate Ali Al Salam. I want to know exactly where it is, what are the surrounding conditions, maybe I want to know something about the surface to air picture there, how electricity is provided, maybe there are alternatives to bombing the site, or maybe I can take out a power plant. The FULCRUM system gives me lots of information and it will help me square away my battle plan for this particular mission.

TACNAT Automatically:

| Extract Content from All Source Messages | → | Analyze Observables With Facility Models and Reasoning System (e.g., Air Sorties) | → | Determine Facility Status (I.e., Infers Sorties and Associated Munitions Deliveries Exceed a Criterion Set By Analysts) | → | Determine Forces Status and Alerts the Analysts Through Color Coded Manipulation of Monitor |

Analyst Manually:

| Reads Original Source Messages | ← | Queries Quantities in Play | ← | Queries Inferences Drawn | ← | Reads Alert |

Example Facilities Built: Airfields, SSM Installations, Petroleum Storage Facilities, Fixed Field Areas

Next slide. From TACNAT--in addition to other sources--information goes from top to bottom at any particular station that you are using. We have order of battle information that comes into the FULCRUM system. We can instantly put information through our order of battle generator and put the resulting order of battle into our flying carpet system, independently of the other routes. So, in theory, there's a system owner who, at the end of the day, states that this is the CINCs sanctioned order of battle for January 3rd, 1991. It's stored and can be consulted later.

So to summarize, the idea of ODIN was to enable a commander by giving him some powers he wouldn't have without the threat of getting shot. My Army friends tell me that any time they can reconnoiter without being shot, they do it. It is fairly understandable, and this is the whole idea here. First, you can travel in space and time rather safely. You're obviously limited to the best intelligence that you can possibly get and the most updated intelligence. I want to come back to that in just a minute. Secondly, you have an ability to analyze. Because you've stored away a lot of data about force disposition, you are able to use a system within our structure that will give you reports on numbers of players, farthest advance, or velocities of advance. And finally, you can store everything rather easily and you can go back and change what you've stored. If, for example, you learn after the war that a bad battalion was six kilometers to the left, you go back and create it by simply arresting that particular icon, moving it six kilometers to the left, and releasing. Then, you're up to date again.

Go back to the slide with criss-crossing curves. There's another problem here, that's not obvious from this chart. I want indeed to maximize the utility of this display system, but unfortunately part of my entire ensemble, namely TACNAT, is a very secure system and can't be used forward in the field for obvious reasons. If we get overrun, we're exposed. The lowest level that TACNAT can be used is corps level. So, in all our searching to understand where this best would fit, we stumbled across a mission called Apache Deep Operations. And, as I understand, Deep Ops were planned at the corps level. It's an aviation mission, it strongly utilizes the aspects that we produce here (namely, timing, coordination, analysis, terrain understanding, and force disposition), and it appears to me to this date to be the best application of the entire suite of ODIN capabilities. And that's where we stand now.

Last chart. As with 73 Easting, the idea is to use ODIN technology to capture and archive something that really did happen the best that we can understand it. These are independent facts. Then we want to run them as an independent dynamic simulation to see how things transpired. Let's take a look, but let's verify with the guys who were in uniform by asking whether this is roughly or more precisely how things really happened? That being the case, turns out that Colonel Wafton over here says that if I had been this Iraqi commander you wouldn't have kicked my butt. Oh, is that right? Why? Because of a principle of war that he neglected. Which one is that, Colonel? After an elaboration, I'm convinced that he might have something. So, let's go man up. We go to the terrain data

CHANGING HISTORY OF THE FUTURE
AND
FUTURE OF HISTORY

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┌─────────────┐    ┌─────────────┐    ┌─────────────┐    ┌─────────────┐
│ Independent │ →  │  Dynamic    │ →  │ Freeze      │ →  │ Master      │
│ Facts       │    │  Rendition  │    │ Action.     │    │ Your        │
│             │    │  of         │    │ Introduce   │    │ Analysis    │
│             │    │  Isolated   │    │  New Ideas. │    │             │
│             │    │  Facts      │    │ Man-up.     │    │             │
│             │    │             │    │ Fight.      │    │             │
└─────────────┘    └─────────────┘    └─────────────┘    └─────────────┘
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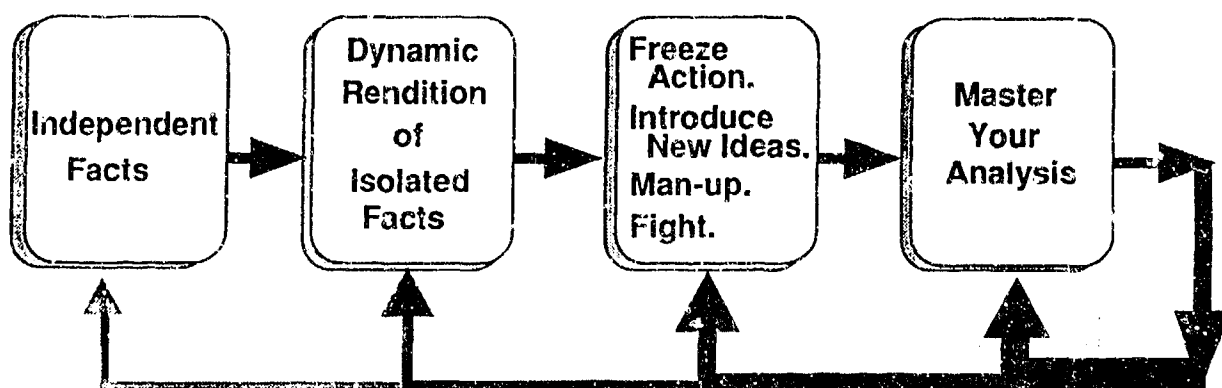
base, we bring the war forward to this point, and we man up. We fight out his tactics, his doctrine. And we find out, sure enough, that Colonel Wafton is correct. Well, technically it's not as simple as all that, as we've been discussing at this conference. But that's where we're heading. After we fight this new fight, let's understand truly what we really did and document it. What I'd like to do now, with Chris taking the lead below at the orchestra pit, is show you some of ODIN's features that you have not been able to see so far. First of all, we'll begin by just laying some forces down on the ground. You can see where we are by now, this is a fairly obvious part of the world. Chris, if you will, just start laying some forces down, as if someone is giving you a HUMINT report and indicate how easy it is to do this. Apparently not as easy as we had hoped. O.K., while we're getting ready, I was just over at DARPA and I don't know if you know about DARPA egos but I'm walking the hall, hurrying, trying to get over here, and I see a man standing like this, this is a joke, I see a man standing like this and I said, excuse me what's your name. He said, "I'm Napoleon." I said, "Oh, who told you that?" He said, "God." The guy in the next office said, "No, I did not." Do we know what's wrong guys?

TURRELL: It just recycled, it's coming. We're bringing it back up.

Q: How much of the populated world is covered by FULCRUM?

A: On a disk, you have an area of interest or a theater of operations. And, for example, during the beginning of the war, the data base was finished for (SAKI) Saudi Arabia, Kuwait, Iraq for FULCRUM. There was already a data base for Korea and for some others. But FULCRUM was utilized independently of our system and for a number of applications in the war, principally by the Navy. I think there were 19 surface platforms that utilized FULCRUM as a stand-alone system.

Q: Do you have to have friendly access to get FULCRUM data, or can you get it from a satellite or some other technique?

A.   I can't speak detailed about FULCRUM. Judith Daly is the program manager for FULCRUM. But my understanding is that it is not unreasonable that you're talking national assets that originally gathered the data. Col. Maune, I don't know whether you want to speak to that question or not.

COL: I really can't.

Q: Basically, the first question is do you have a map. The second question is have they gotten around to putting it on laserdisk.

A: Yes, it's as simple as that. Let's investigate the example that I gave about Ali Al Salam. Ali Al Salam flies A-4s. Ah, it says, what about A-4s? Point and click-- manufactured by K Mart corporation, last item delivered in 1972. What does it fly? It flies Mark A-4s or drops Mark A-4s, has a loadout capacity as follows. Mark A-4s are distributed from the following location, and the number of trucks leaving this plant also has increased by a criterion that you, as a human being, have set. The combination of those two inferences caused me to tell a human being to look out for Ali Al Salam.

Chris is laying forces on the deck, or as you say, on the Earth.

Here is an interesting solution to a problem. The question of granularity in resolution that I mentioned before with the criss-crossing charts. If you are a commander, a strategic minded commander, you don't want to see tactical pictures, you don't want to see tanks on the ground, you could not care less about that. You want to get a bigger picture so you want to get real tall and see a lot of terrain. Therefore, we chose to put icons on the ground and position them at the center of gravity of that particular force. So if you know there's a battalion of tanks on the other side of the mountain, then there's a flag that comes over the mountain that says, the bad guys are over here. Now we were lucky with this particular terrain because it's fairly flat and somewhat uninteresting. But with a terrain

like Fort Knox, or most of the rest of the world, the power of the ability to see this in 3-D even from a very high tactical level I think is pretty obvious. All right, Chris.

TURRELL: We'll take a look at some actual tactical forces now.

At present, if you're looking out the window at the company level, you see the individual units. At battalion level or higher, you see the symbol or the unit icons. (Having some problems here, operator error)

Let's do intervisibility plots, Chris. You just noticed, as you have in the past day and a half, that you can zoom in and out, fairly readily. Let's say you're planning a particular movement and you want to determine the visibility that you impose or you wish to have. Chris is moving from one position to another and you're indicating over space actual elevations.

TURRELL: We created a 2-D cross-section. This system has data imbedded within it so that we can do that. We can also, by using this technique, do a radial line of site. You'll notice the different colors along the lines, the areas in white are fully visible from the observers perspective. The observer is always 2.6 meters above the ground, essentially an armored vehicle commander's perspective. Those in green are partially obscured, and those in black are obscured to the observer from that location.

I was going up to see if we could find this platoon of tanks from the direction of...Apparently our stealth is locked up again. They'll reboot it.

McBRIDE: How many of you have you got a tour of the van? Can we go ahead and put some control measures on the plan view display?

TURRELL: We have a number of linestyles, the solid line and the dashed version of the plain line that I'm showing now will show up on the 3-D display, and I say that with a certain amount of reservation...but we'll...there are things occurring here that I really can't explain...I don't think that I've ever seen this and I've been with the program for a year now...

CLOVER: We obviously have some high ranking VIPs in the audience. That's the only time it does this.

McBRIDE: Well, we've had this idea for some time now called network aggressor. The idea is that, at some unspecified location in the country, there are people sitting at work stations who can dial into your simulation war. They might decide they want to be F117s. You're fighting this exercise at Fort Knox and out of nowhere comes these F117s and ruin

your day. We had scheduled for the network aggressors to be ready in about two years and apparently we're ahead of schedule.

TURRELL: We'll take another shot at projecting this line style.

McBRIDE: Right now that we're talking with special operations community who would be very interested in sitting at a table and using maybe a helmet mounted version of this technology and brief a plan to, for example, kick in a door where I want you to go to the right and you to bust through that door that hinges to the left, and we'll plot out our command and control mission here. We can walk through it and understand completely who's going to do what and what our timing is. The idea is to build your confidence, build your understanding of the rea, and provide yourself with options that you might not have thought of if you haven't seen where you're going. O.K., Chris.

TURRELL: They're going to have to reboot the system in the van.

McBRIDE: Let's do questions.

Q. What language i it in?

A. (McBRIDE) Is 'it" in.

Q. The software.

A. (McBRIDE) 'ariety of languages.

Q. Is this oing to evolve now into second generation? s this program completed?

A. (McBRIDE) Don't think of the hardware and software that you see physically here right now is a system. It is, in fact, but it is not a deliverable system. Although we will no doub/ nansition it to someone who can use it. The breakthrough, I think, is in the fusion of the technologies. Therefore the design is what was produced here. When a commander needs information from various sources very quickly, all he has to do is point and shoot t it and magically it appears in front of him. That's what we are trying to provide. Ou specific thinking was that there's no better occasion than when a war is really happening 'nat we can get the adrenalin, the testosterone, the whatever involved in the design process to understand what the end product needed to be. So this project ODIN will be phased out this year and other technology will be phased in. Status report, Chris.

TURRELL: It's rebooting.

McBRIDE: What other questions, as we go here?

The vision, in fact, the concept developed at Fort Rucker is as follows: you have a deep operation mission that you're going to pursue. You would first plan out on paper by talking to others what it is you're going to do. You use this equipment to go visit the area and we can talk about it and let's argue about our approach route, our egress routes, our altitudes, and velocities. Let's argue about it first while we're looking at it. Once we've done that, we'll plan it out in detail. Here are my way points and my times. Everything is understood. Let's now use semi-automated forces and have things actually fly to their way points and complete their mission to understand the timing. Then at Fort Rucker, given that this is all done you go man up the simulators. You have the SAK1 data base loaded, you man up simulators and you fly the same mission and then develop your concept of operations and your basic combat.

The relationship to SIMNET, most of which is obvious, is a utilization of protocols and the object oriented programming that I specified earlier. Also the CIGs that we used are the same class of CIGs. The semi-automated forces are something that we brought from SIMNET, but we're now using (or will be using) the MIPS machine to host semi-automated forces.

McBRIDE: Any other questions? Let's take a break, take the pressure off getting booted up, and we'll try to get reorganized with the software and reconvene in 10 minutes.

--73 EASTING--

"WHAT IF" EXERCISES
(PANEL DISCUSSIONS)

28 August 1991

Panelists:

General Larry D. Welch, USAF (Ret'd), President, Institute for Defense Analyses

General Max Thurman, USA (Ret'd), Association of the U.S. Army

General Paul Gorman, USA (Ret'd)

Major General Matthew Caulfield, USMC, Commander, USMC Warfighting Center

Rear Admiral Richard Allen, USN, Assistant Deputy Chief of Naval Operations

Brigadier General Gerry Galloway, USA, Academic Dean, U.S. Military Academy

Colonel Doc Dougherty, USAF (Ret'd),
Defense Advanced Research Projects Agency
--Panel Moderator--

INTRODUCTION TO PANEL DISCUSSIONS--
COLONEL DOC DOUGHERTY,

Good afternoon, I'm Colonel Doc Dougherty. This afternoon we have a panel session to discuss the future of simulation technology. But before we do that, I would like to point out something that I don't think was brought to the attention of the group yesterday. This whole 73 Easting process started one day in General Sullivan's office. The guy who had the insight is sitting right here, in the front row, he's wearing a badge, and it says he's the chairman of this conference. Jack Thorpe, would you stand up for us? Jack and I had gone to General Sullivan's office to talk about applications of simulation. General Sullivan was describing some battles that had recently taken place in Iraq, and Jack had this flash. He said, "I just got this idea, maybe we could use simulation to capture some history." And General Sullivan said, "and I have just the battle for you." Over the next five minutes everything except the dollars, and whose pocket they came out of, was agreed to. Later that afternoon, Vic Reis signed up to provide the resources and told Jack to go do it. From then until now, Jack has been the driving intelligence behind making this thing happen. So I think Jack deserves a great round of applause for having done a super job.

We are indeed fortunate today to have a distinguished senior panel of simulation experts consisting of three retired generals, one former Air Force Chief of Staff, two former CINCs, and three active duty flag officers from the Navy, Marine Corps and the Army. With the tolerance of the most senior members of the panel, I would like to introduce each panelist, beginning with the junior member.

Brigadier General Gerry Galloway is the Dean of the Academic Board, United States Military Academy, West Point, New York. As an engineer he's held a wide variety of important positions in the Army. He holds masters degrees from Princeton and Penn State, and a Ph.D. from the University of North Carolina. He still teaches classes at West Point and strongly encourages the use of simulation in the academic program.

Next, Major General Matthew Caulfield is a deputy commander for warfighting and director of MAGTAF warfighting center, Marine Corps Development Center at Quantico. He has held numerous important positions in Washington, DC, including duty at the military office, The White House, the OSD staff, and Headquarters, U.S. Marine Corps. He's held equally important, if not more important, positions in the field, from company command in Vietnam, to battalion and brigade command in the States and Okinawa.

Rear Admiral Richard Allen is the assistant deputy chief, Naval Operations for Naval Warfare in the Pentagon. He's a naval aviator, he commanded CV66, which is the carrier U.S.S. America. He served as commander Carrier Group 6, and in his present job he is concerned with air related tasks in OP-07B.

General Maxwell Thurman is an associate at the Association of the United States Army in Arlington. Before retiring from the Army he held three four-star jobs--Commander in Chief, United States Southern Command; Commander, U.S. Army Training and Doctrine Command; and Vice Chief of Staff, U.S. Army, here in the Pentagon. As we all know he was the leader of Just Cause, that resulted in the capture of Noriega.

General Paul Gorman, is the president of Cardinal Point, Inc., which is an entrepreneurial house of training concepts. He's a practicing viniculturalist in Afton, Virginia. He even has his own label. Before retiring from the U.S. Army, he was Commander in Chief, United States Southern Command.

On the far end we have General Larry Welch, who is the President of the Institute for Defense Analyses, headquartered in buildings right across the duck pond here. Before assuming the presidency of IDA, General Welch was the Chief of Staff, United States Air Force.

With that, I'd like to start with General Welch. We're going to have each of the people provide a summary of their thoughts about where the technology leads us and how it might be applied. At the conclusion of one round we'll open it to questions from the audience.

GENERAL LARRY WELCH

Let me take just a minute to give you some glimpses of some thoughts. Doc has given me the assignment of talking about the potential for Advanced Distributed Simulation contributing to OSD decision making. In doing that, I will inevitably touch on some themes, or some variations on themes, that you've already heard. And you will hear other variations of those same themes from people who will follow. That's not surprising since there are a set of themes that OSD decision makers face day after day, week after week, year after year. I'll focus just briefly on what I regard as three classes of OSD decisions and talk about some of the potential I see for applying this emerging combination of technologies that we call Advanced Distributed Simulation.

The first class is the basic priority choices between the four pillars. Almost anyone who has been involved with PPBS knows it is a constant struggle to balance readiness, sustainability, modernization and force structure. Sustainability seems to take a back seat in peacetime and force structure tends to be an output from the modernization program and the budget, so the decision process focuses more on the balance between readiness and modernization. I'll say a few more words about that balance and those priority choices in a minute.

The second class of OSD decisions tends to be the balance of capabilities within a modernization program and of course ultimately within the force. One of my favorite themes is that we live in an uncertain world, in that it is not possible to attach one scenario to an approach to defining the ingredients of robust, resilient, flexible forces that can serve U.S. interests in places that some of us have probably not yet thought about. So there's a real need for a much more sophisticated, robust approach to defining that set of capabilities and the balance within the capabilities and I'll say a little bit more about that.

The third class is more specific. That has to do with determining the military worth or the potential military value of various modernization programs or existing programs within that set of balanced capabilities. That's the age-old cost effectiveness problem. Where, quite frankly, we understand costs for more than effectiveness. So the great difficulty is with measures of effectiveness that have high credibility and that are convincing to OSD decision makers.

There's a fourth class of questions that really are not part of my assignment. But I will mention that they exist in hopes that someone else will talk about them. That's the business of learning how to use the emerging capabilities or new capabilities, particularly if they are significantly different in their overall approach from existing systems or systems with which we have a lot of experience. Some examples of that are J-STARS. We took J-STARS into Desert Storm with little experience on how to use it, how to leverage its capability.

So those are the three areas, with the fourth, that is really an adjunct, though an important one. In the first area, in the matter of balance of priorities, what you have heard in the last two days on 73 Easting has provided important insights on this balance question. During the course of Desert Storm, we heard authoritative, public statements from Congressmen and others about what that balance ought to be. The pendulum has swung from technology, was the champion, suggestions that technology was the decider in terms of the outcome, to the other end of the spectrum, that it was the quality of the American

airman, soldier, sailor and marine. It has been suggested by some that the quality of the U.S. force was so great that even if we had swapped equipment, we still would have won by a very wide margin. As a result of those differing views, some believe that we can defer modernization. Just before Desert Storm there was a serious proposal to this effect in the House Arms Services Committee--the perception being we were so far ahead in technology and that the threat had decayed to the point where we really didn't need to continue too much to stay on the leading edge of fielding technology. Instead, the perception was that we could afford to develop technology and put it on the shelf and then if a suitable threat emerged, we could just pull the appropriate technology off the shelf and field it. I relate that discussion simply to illustrate the wide variety in opinions about the subject and the need for more objective enlightenment. Clearly, 73 Easting tells us that it takes high quality people to leverage technology or said the opposite way, it takes technology to leverage the capabilities of high quality people. The question of whether or not we have the quality in people and the training required to leverage the effectiveness of sophisticated equipment is decisively answered for the battle of 73 Easting; by the attacks against Baghdad, and by other examples in Desert Storm. One of the important things that can come from distributed simulation and particularly from reconstructions, like the battle of 73 Easting, is not just understanding the payoff from the combination of high readiness and advanced technology but the presentation in a way that brings it to life in a convincing fashion that I would think would tend at least for some time to put an end to the endless arguments about whether or not to trade off quality of personnel and quality of training and modernization. Clearly, we have to focus on the high end of both and we can well afford to do so.

On the matter of balance of capabilities against needs, OSD decision makers and OSD planners are far from satisfied with the state of understanding about what kind of conditions are we likely to face in the world--the scenarios that will drive the strategy, that should, in turn, drive the capabilities required to underwrite the strategy which defines the military equipment and organization and training required to provide the capabilities. But all that starts with some view of the scenario based on some view of where the threats are. Decision makers are currently challenged with moving from the well worn, well understood, endlessly exercised, middle European scenario, which has served as the primary driver for forces for some years. To illustrate that challenge, General Colin Powell's answer on several occasions to the question of, what's the next scenario, where's the next threat, has been some variation of "beats me." The fact is that's probably

the only straightforward answer today. But that's not a very good definition of what leads to the kind of forces required.

I mentioned in my opening remarks the role of chance. But I think that it's important to clarify that chance, the outcome of chance is defined by the nature of the forces. I'll give you an illustration using the battle of 73 Easting. When the 2nd Armored Cavalry, seeking to reach out and touch the Iraqi forces, found themselves suddenly engaged with main force elements of the Iraqi brigade that chance occurrence could have been a stroke of very bad luck for the 2nd Cavalry. But it turned out ot be a stroke of good luck. The 2nd Cavalry exploitation of the situation made it a stroke of good luck--because of the nature of the organization and the training and the mind set and equipment of the 2nd Cavalry.

So the question is, how to structure forces that can deal with uncertainty? Uncertainties regarding where they will be employed and for what objectives, uncertainties about what will happen in battles within those theaters of employment and how to define, resilience, flexibility, adaptability or the ability to exploit chance--the ability to maximize good fortune and to minimize bad fortune?

There are lots of battles throughout history that historians, tacticians, strategists and military leaders study in hopes of catching glimpses of the qualities that determine the outcomes of battles, those qualities that enable forces to deal with chance. I need not go through the litany, but I have very little faith that we fully understand those qualities and those battles, because we don't have the advantage of playing them over as we do with the battle of 73 Easting. This technology gives us that opportunity.

But even more important than just playing them over, I think it could be a terrible mistake to conclude from the reconstruction of the single battle of 73 Easting that those qualities that we saw making such a difference in that battle provide comprehensive insights into the qualities needed in the force in general. For example, there was virtually no infantry play. I presume you would not conclude from that that infantry is not important. The point is that it identifies areas worthy of examination. And if we had this kind of tool that could allow us, within reasonable parameters, to play various factors to see what effect they might have on the outcome under other conditions, against a different opponent that makes different kinds of decisions, that could be an immensely important aid in defining forces that can deal both with the uncertainties of where and why they will be employed and the uncertainties of what will happen during that employment. I think we have the opportunity to do that.

For example, I think that we can put together, in the southwest United States, a combination of training areas and simulations of various kinds in an advanced distributed simulation system that can greatly intensify the quality of training; that can provide training to multiple echelons of combat leaders, from those who make theater decisions to those who make minute to minute decisions during engagements, and that can also provide a great many more insights into how forces can best be structured and balanced to deal with those uncertainties. The possibilities are almost endless, and it's a promising area for some focus. The third area is the business of understanding effectiveness or coming up with convincing credible measures of effectiveness. That has been an immensely frustrating experience over the years. A lot of people in this room are thoroughly familiar with what I call the half live tests we have constructed over time to try to get some insights into military worth or military value. There were the TASVAL and CASVAL series of exercises to gain some insights into how we should provide tactical air support, both fixed wing and rotary wing to the ground battle. Those were expensive, time consuming tasks from which we gained some insights, the most important of which were how to design the next test. Subsequently, the decision on an Air Force follow-on close-air-support airplane was delayed for four years by arguments over the nature and the merits of the next close-air-support test to get more insights on the kind of qualities most important in a new close-air-support system.

The ACEVAL/AIMVALs series of tests were designed to gain insights into qualities most important in modern air-to-air combat and what kind of missile concepts will be most useful. Again, expensive, time consuming tests from which we gained some important insights. But, one of the insights was that the best concept for an IR guided missile was the AMRAAM which, of course, is a radar guided missile. The point is that these half live tests seem to have been the only credible means of providing insights required for decision makers to believe that they had what was required to make the decision. There are lots of examples, but I won't drag you through the whole litany. But it should be clear that advanced distributed simulation is a promising way to help with multiple iterations at significantly higher realism and probably significantly lower costs. But I would stress higher realism over lower cost. It may surprise you to hear that I expect higher realism out of advanced distributed simulation than from most live fire tests. In the first place, live tests are only half live. They are constrained in area to the point that we don't explore most of the real life battlefield dimensions associated with the employment of the equipment being tested. They are half live tests in that we can't really simulate the exchange of fire. In CASVAL TASVAL, the people who manned the ground defense systems were the most

courageous people on the face of the earth. There are all kinds of artificialities that we simply can't handle in half live tests.

So what's the answer? In some cases it may be the full electronic battlefield that you've heard described. In other cases it may be combinations of live systems, operated by real operators and real systems on instrumented ranges and simulators tied together in some kind of an advanced simulation network. But, again, it's an area where it seems to me that advanced distributed simulation is very promising.

GENERAL PAUL GORMAN

One of the chances for which we can thank our lucky stars was that VII Corps and the 3rd Armored Division were not called upon to perform the missions assigned them for DESERT STORM back in 1970 and 1971. I think any soldier here would agree with me that there was no bloody chance that they could have pulled those missions off with the forces that then existed. General Funk, in his remarks at the outset of this conference, alluded it to the fact that the performance of the force in DESERT STORM was a function of the five major weapon systems that were fielded between 1971 and 1991, plus a major difference in the way the Army trained its forces for such contingencies.

If any of you wish to take yourself on a documented tour of Army training concepts back in 1970 and 1971, I refer you to Field Manual 105-5, which in the then-current version carried forward the ideas introduced into the Army by George Marshall and Leslie McNair in the era of World War II, that the way to train higher commanders and staffs for their responsibilities was to conduct large field exercises, or maneuvers of the Louisiana variety, ideas perpetuated with the STRICOM and Readiness Command exercises in the United States, perpetuated by the large exercises of the Autumn Forge series in Europe for years afterward right into the 1970s.

Also in that early 1970s field manual, Annex B, you will see described a live-fire field exercise for the rifle platoon, virtually identical to the live-fire field exercise for the rifle platoon that was published by Army Ground Forces in 1943. Such training was predicated on three assumptions.

Assumption no. 1: realism in training involves live firing.

Assumption no. 2: live firing entails surprize targets, so there were silhouette pop-up targets.

Assumption no. 3: conservation of ammunition should be taught along with accuracy. So the scoring system that was devised rewarded hitting targets and saving ammunition, bringing ammunition back, teaching soldiers not to shoot unless a target is in sight.

My friends, the simple explanation for the observations of S.L.A. Marshall, and countless other observers, myself included, on the fact that American riflemen rarely shoot in combat can be traced back to the way they were trained. They didn't shoot because they didn't see anything to shoot at. They'd been taught that ammunition conservation was what was important, not suppression of the enemy. In fact, the notion of suppression never figured in the training exercises that the Army used in those days.

What happened in the 1970's was that the U.S. Army adopted in its tactical training the simple notion of engagement simulation, in which the unit in training is pitted not against cardboard targets but against a thinking enemy--an enemy that could shoot back. The Army equipped both with mechanisms that introduced into exercises in close combat, suppression and some of the other major factors that bear on proficiency in combat, like teamwork in fire and movement, proper use of tactical cover and concealment, and the like. That's the real beginning of the so-called "revolution in training" that prepared the Army for DESERT STORM--I think Dr. Anne Chapman used the term, in her TRADOC Historical Study, *The Army's Training Revolution 1973-1990* .

Further, Gen Bill DePuy of TRADOC was informed by simulations about training standards to set for the force. Some of you here may be old enough to recall TRAINCON 76 in the United States Army Europe. Bob Sunnell sitting back there, I know will recall this one. DePuy went to his combat modelers, and asked them to analyze how many targets the average company team defending in Central Europe would have to contend with in the opening battle of the next war. The answer, incidentally, was 60 armored vehicles. That gave, with the closure rates that were assumed for the Soviets, twelve minutes to serve those 60 targets, and by the way, the opening range was 1200 meters. DePuy then took that data, went over to Europe, trained a tank company up to that standard, and ran a demonstration in which the tank company in fact serviced 60 targets in 12 minutes. He turned to CINCUSAREUR, and said your tank gunnery standards are not up to that kind of shooting. You are going to have to raise your tank gunnery standards, you are going to have to teach your units how to fight as teams. Not as single tanks, as on Table VIII, but by platoons and companies. Fire distribution is of crucial importance in such teamwork. This incidentally, at TRAINCON 76, was supported by testimony from the people who

had undergone the training for the TRAINCON shoot. Note the similarity to what General Funk heard in the after action review from the 3rd Armored Division. I would infer that the ability of Paul Funk's lead battalion--cresting, and seeing to its front an Iraqi tank battalion in column--to eliminate a battalion's worth of targets with two volleys, goes back to the autumn of 1976, and that shift in tank gunnery standards, and other techniques for close combat in the armor force.
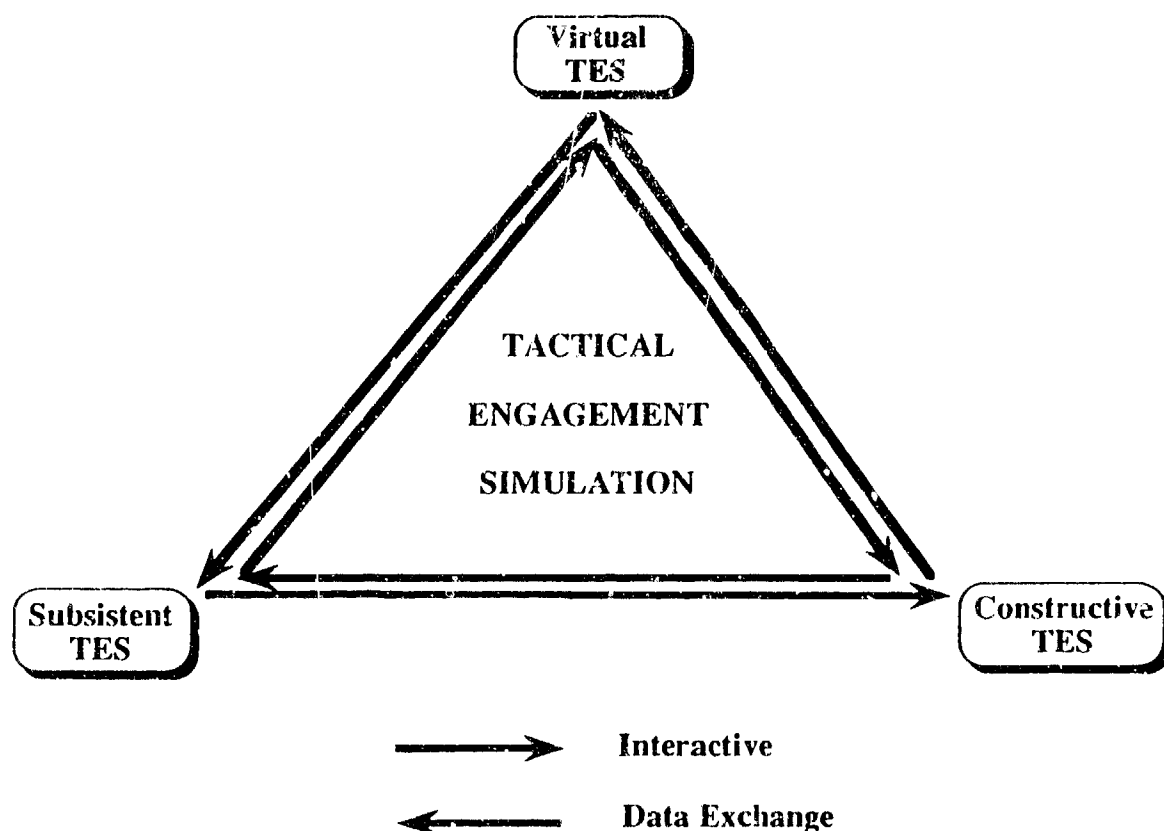
That shift came out of a simulation, a model, a mathematical model of combat, a construct, if you will, a way of thinking about close combat. You all have been exposed here, through *Easting 73*, to a new method of thinking about, of portraying, close combat. In my view, it is an enormously valuable forward step, precisely because it is fully apparent when you look at it why things happen, unlike the esoterica of Lanchestrian models, and in the intricacies of the computer interfaces that one has to deal with to get at combat ground truth through that mechanism. There's a sort of a face validity at work here.

Paul Funk also made mention of the National Training Center, which was sort of a broad, large scale application of engagement simulation to training battalions and brigades.

There are then, I submit, three forms of this art of engagement simulation now available as tools for the armed forces of the future. It strikes me that one of the imperatives that ought to come out of this conference is to ensure that we can take advantage of all three forms, so that one form of engagement simulation can be used to improve our understanding of the others. Again, to go back to the 70s, our early experimentation with tactical engagement simulation of the subsistent variety, that is, the actual performance of units in the field, equipped with weapons effects simulators-- initially, very crude stuff, eventually laser engagement simulators--demonstrated pretty conclusively that we could raise the effectiveness of American infantry and armor units in close combat by a factor of two. A factor of two! General DePuy, Commander of TRADOC, was making speeches at the time saying even that wasn't good enough, because we had to expect odds of 1 to 4, which meant we'd better be four times better than any adversary. But he was pretty clear in his own mind that the Army on the right track toward such proficiency.

Now let me have my chart. What I am trying to argue with this visual is the proposition that there are three forms of tactical engagement simulation, each of which has been demonstrated as an effective training technique in the U.S. Army--and indeed, I believe, in all of the Services. The Army learned how to do this, as General Welch knows

well, by watching the Air Force at Red Flag, for he was one of the prime movers in setting that exercise up for General Bob Dixon. The Army watched the Navy out at TOP GUN, that's subsistent tactical engagement simulation--force on force, pitting the aviator against a wily, skillful foe and teaching him experientially how to cope with the problem of modern air-to-air combat.

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                        Virtual
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                     TACTICAL

                     ENGAGEMENT

                     SIMULATION


Subsistent                                    Constructive
  TES                                             TES


                 ─────────▶  Interactive

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I believe that what you have seen here in *73 Easting* is a glimpse of what is possible with the third corner of the triangle, virtual tactical engagement simulation. I would argue moreover that you are looking at the onset of technology that could make a major difference in the other two forms. Let me make myself clear. Vic Reis spoke to us about the prospect of s all, light satellites bringing about a paradigm shift in the way we think about satellites. My proposition would be simply, OK, DARPA, let's have a demonstration set of satellites over Larry Welch's southwestern United States' theater of war. Let's put up a satellite array and use that satellite array exactly the way we used satellites in the DESERT STORM. And I'm quoting here Vic Reis' testimony to the Congress from DARPA's TACNAT program, "timely intelligence data on the locations and status of units were overlayed on an electronic 2-D map of the theater. From our FULCRUM project, friendly force and environmental data were added on the same map."

We happen to have, in the force today, intelligence mechanisms that can solve most of the field-exercise instrumentation problems that have heretofore depended upon relatively large computers, radio towers, triangulation, and other apparatus. We could improve the instrumentation of our exercises by an order of magnitude with the application of this ODIN-TACNAT-FULCRUM technology like that you have seen demonstrated. Moreover, training occurs in the after-action review, when one has an opportunity to figure out what it was that happened. Being able to do that after action review vividly, completely, in the sense that you were able to roam around through this land battle at 73 Easting, would be an enormous advantage for learning.

My recommendation is that not only should DARPA put up the satellites to make it possible to use ODIN, but also deploy ODIN out there and put it in support of that model theater of war. This would then pull forth from ongoing training exercises, reliable data on how forces actually behave in the field, data we need to improve our models of war. Most of our difficulties with constructive tactical engagement simulation is exactly that they represent mathematical constructs that sometimes were guessed at, or assumed by those who put the construct together, not closely related to behavioral data. By verifying or supplementing the parameters of these models, we can ensure that the models are a better replication of how forces actually behave, which would make them more useful for training, or for any of the applications to acquisition or test or operations that will be discussed, I am confident, by my colleagues. In short, this is a vision, I submit, of where we ought to be moving this art. You've been shown some new and powerful tools. All we need is the will to get on with it. Thank you.

GENERAL MAX THURMAN

I've been asked by Doc (Dougherty) to talk a little bit about the application of the power of the technology that you've seen in the last couple of days with respect to doctrine writers and performance standards. Let me just suggest to you that I'll not talk about the specifics of the reconstitution of 73 Easting, rather, it is the power of the technology that undergirds the simulation that you've seen which is important, I think, for the future and toward Paul's (Gorman) point. If you interrelate doctrine with being what 51 percent of the people believe and act on, then it's highly a function of the equipment, the force design, the leader development and the training that ensues, in the operation of that equipment in terms of the doctrinal aspects of which we want to get out of it.

If you look at Fort Irwin as a simulation, because it is not real combat, but we don't think of it as a simulation, we think of it as something different from a simulation, but it is a simulation and Red Flag is a simulation. Then we could ask the question how many times will the average army battalion commander get a chance to do a full-up battalion attack or a full-up battalion defense in his two-year tour as a battalion commander. The answer is he will do two to three battalion offensive operations and two to three defensive operations because the paradigm is that he will go to the National Training Center once during this tour and the average guy does that and the outlier may do it a little bit more frequently. When we look then, at what are the results of activities at a place like Fort Irwin and what can we learn, not from a single engagement, but let's say, 100 tank defensive engagements or tank offensive or mechanized task force engagements offensive or defensive. We begin to get an insight into what is the use of the equipment against the doctrinal reason for which we bought the equipment.

Let me use a homely illustration--that was put to the lie by 73 Easting. We discovered this situation several years ago. It gave us a chance to train differently and adjust our training techniques and our doctrinal techniques. I ask the question as a TRADOC commander, tell me all about the TOWs at National Training Center and in 200 offensive and defensive engagements each, total of 400 battalion engagements, we found the average opening range of TOWs to be 1800 meters. Now you may say that's perfectly reasonable, the only thing is we bought them to be ranged at 3400 meters in order to make sure we picked off the tanks before the tanks got in an engagement range, that could pick off our own tanks, and therefore, the weapon for which we have sunk anywhere between 12 to 20 billion dollars, if you count up all of the costs of the Bradley fighting vehicles, all the improved TOW vehicles, and all other TOW carriers, plus the munitions we have a sizeable investment stake in it. The answer is, that learning on the simulation at Fort Irwin, we can learn about doctrinal work. Now, if we proceed from that and we make changes then either to get out of the weapons system what we thought we were going to achieve with it, which is opening engagements more like 3000 meters through training techniques, revision of the doctrine, encouragement of leaders to use it in the fashion of which we bought it. Then we can really begin to get at the 2 to 4 times increase in the weapons proficiency of our units that were certainly demonstrated in a case like 73 Easting.

So what is the lesson out of all that? If we change our simulation base from vehicular simulation in the desert, or to the power of the simulations that you've seen undergirding the 73 Easting world, my view about that is, just for openers--when we had

the long debate between the Army and OSD, back to Larry 'Welch's commentary, about what are the relative numbers of scout aircraft to apache aircraft, should it be two scouts and five apaches, should it be two scouts and three apaches, should it be zero scouts and three apaches--I'm suggesting to you, that can be done in simulation. In hundreds of repetitions with hundreds of different pilots, that will give you the answer in much finer grain detail or give you better insights from which you can make those decisions, than carefully crafted but half live tests, that General Welch described in TASVALS of the past. At the moment, on the floor of the desert, or the valleys of Hunter Liggett, we have the M1A2 tank. And there are five of them out there. They're going through their paces to prove the relative merit of upgrading the M1A1 to the M1A2. I submit to you all that can be done by simulation in the types of boxes that we used to know that were located in the SIMNET test apparatus located at Fort Knox, Kentucky, to the degree that we could make judgments about whether the investment is merited.

As we look at the prior test in the Army of the division reorganization that John Foss participated in as a brigade commander, where we tried to determine the relative merits of three tanks in a platoon versus five tanks in a platoon and spent the time and energy to reorganize a division to try to get those answers, I'm suggesting they can be done in boxes by simulators and you can get the insights necessary to tell you that we'll add three and five and that's eight and divide by two because the number of options we're interested in and so the tank platoon is now four! The whole point of it is, though, that we're going through another series of test designs as we think that our forces will shrink, and therefore, we'll get an insight that we can do more testing with this kind of simulation in the future that will give us answers.

As I look back at my own experience in DIVAD and Aquila, DIVAD was plagued with the problem of stationkeeping of the DIVAD with the tank force while trying to do the air defense operation. We found out that the crew chief could not do both and therefore didn't do either well and could not do the task associated with that and the program was killed. Similarly, not enough simulation was done up front on the processes involved in Aquila which was a new weapon system that we didn't know how to operate and we lost that one as well. So with force design, we can clearly get an insight into what are the measures of effectiveness that we can use to determine whether we should make dramatic shifts in our force structure or not. Now the freeplay, force on force, that is in the paradigm at Fort Irwin today or Red Flag today, is also available in the technology undergirding 73 Easting. In other words, some people may say the Iraqis didn't fight very

well, but if you put a smart guy on the other end of the system, he can fight those as well as you want to fight them. You can ratchet that up on whether or not you give him a 1/10th of performance capability or 0.5 or if you want to make him a full-up system of 0.8 or 0.9, that can be done in a way in which that is fought and we know how to do that in our simulations with computers like JANUS and the like. Now I'd like to change to doctrine writing in the larger context of joint operations.

At the moment we have invested heavily in AEGIS simulators, Patriot simulators, and AWACS operational vehicles and the like. I can certainly envision that if we had a connecting link of standards, in which these devices were told to be hooked up from the get-go, when they were designed by the industry, it is perfectly reasonable, from my viewpoint, that the CINC in Tampa could have AWACS flying anywhere he wanted to in the world, hooked up with Patriots at Fort Bliss, Texas, and AEGIS cruisers, sailing anywhere they were, or in the AEGIS simulators that may be located in Dam Neck or elsewhere in Virginia. In order to play that out in a joint force role because air defense obviously is a joint function and anything we do to write the doctrinal manual has to take into consideration what are the system capabilities at the moment, their deficiencies and their contributions to a joint air defense battle, because you can't have an air defense battle that is not joint. Similarly, I don't think there's a chance of having the full replica of target sets available for 8 TACAMs to shoot at that J-STARS can find, except through a simulation process. And therefore, it would be perfectly reasonable now that says as an adjunct to General Welch's southwest theater training center which encompasses, 29 Palms, Nellis, Fallon, Irwin, and Miramar all hooked up, not by OSD or the joint staff running each one of those, but by standards set about what the engagement simulations will be. Then it's perfectly reasonable to say that 8 TACAMs can play at Fort Irwin and strike targets in a virtual simulation at Nellis with AWACS or J-STARS flying in those operations. The power of the technology that undergirds the 73 Easting can be brought to bear in that regard. Now, we must realize the wave of the future is joint operations, we saw that in Desert Storm. We saw an army tank brigade fighting with a marine division, supported on any given day by Marine, Air Force, or Navy aircraft. Then the question is, do we practice fighting that way on a daily basis? The answer is, we do not. We practice mainly in compartments and these should be hooked up from the point of view of the engagement simulators at each one of these places has to be able to talk to the engagement simulations at the other places.

Finally, in the standards, which I was asked to describe a little bit, I would suggest that the standards begin in the research, development and acquisition process. I noted with some interest, I think in *Defense News* of Monday a week ago, a little note that the U.S. Army test and evaluation command was procuring a 32-million-dollar system for simulation and engagement war associated with tests to be run at CDEC and also was able to be transportable to anywhere in the U.S. Did that system require interface connectivity to the existing engagement systems that are already located at the five training centers I've just described or the training center that's located in Europe? My gut feeling is that that was done in a stovepipe, not by ill will, but just was done in the testing stovepipe. So my point is that, even as we speak, money is being allocated in various segments of all departments in research, development and acquisition testing and training but the common standards which would cause the simulators to net has not been prescribed by anybody and therefore they won't. That, to me, is a simple thing to be done. I would commend that part of the outflow of this operation should be that that be done in about 90 days and be retroactive to all existing contracts that are currently in this particular deal. Even as we speak somebody is building the crew simulators for the LH helicopter. Therefore, it's not just for the test purposes of bringing along the design of the LH, it's what that helicopter is going to be used for in its scout role associated with ground mobile units. And therefore, will it net with the ground simulators located at Fort Knox, Kentucky, today in order to play that role out as the aircraft is being brought along? Because it's not being brought along just for its own sake. So if I had two notions that should come out of the discussions, from my standpoint. One is that we should have a set of performance criteria for the internetting of these equipments in both R&D, simulations as well as in training simulations because the congruence of those over time, is clearly doable. And second, I would echo a strong affirmative stand that the joint staff take under its aegis immediately, the notion of creating engagement simulation standards for the armed forces of the United States, so we can get the sinergy out of training that simply is of an estimable value in combat. Thank you very much.

RADM RICHARD ALLEN

I certainly agree with the previous speakers, particularly from the Navy point of view, with respect to the requirement for joint training and internetting war games and tactical simulations. We have taken that on within the Navy within a team that we call Team Mike chaired under the 07 organization. It's embryonic right now, but I can guarantee you that we do intend to pursue it.

We do not have adequate at-sea embedded simulation. With embedded trainers you can take the 19-year-old young man, place him at a work station, the same work station on the same equipment that he would use in combat, and with great fidelity display a simulated scenario to him, and allow him to react to that scene. The operator does not know if it's real or simulated. It exists now, to some degree, limited in scope and functionality in my view. The overall performance of it has great shortcomings, and we currently do not internet it with ships at sea.

We take a stab at this training, in what we call BFIT, which is Battle Force In Port Training. BFIT is done prior to major deployment for every deploying battle group. We *do* some land line connectivity, but we have protocol interface problems, data base exchange problems, and what training we do achieve from the BFIT process is met with great difficulty. We must do better in internetted training, we know that.

We do some, what we call, tactical air combat training system on both coasts. These are instrumented ranges, as was mentioned previously, where we fly airplanes against airplanes, or airplanes against threats. We then try, through some playback mechanism, to bring the guy back down, land him, stick him on the machine, and let him watch what he did in relation to what the other guy did. It's a very valuable system for the aviation side of the house. We do not have a similar way of playing that same type of scenario, the Red Flag type of scenario, if you will, with battle forces at sea, force-on-force engagements.

We need to take the technology that is being worked on here (73 Easting) and figure out how to take it to sea, not only in the pure blue water scenario, but more importantly, on the seam of the land-water interface. We can play that scenario at sea in a simulation event, to allow training to take place during forward presence operations, tied to the Unified CINC or the component commanders. We need to get day-to-day training such that when one actually engages he may be looking at the same terrain he has looked at in simulation. He is looking at the same, or quite similar, order of battle laydown, that he saw in his simulation. In a close air support or force-on-force scenario, in support of the land campaign, we'd like to think we've seen it before. I think there are some tremendous benefits to be gained if we can figure out how to do that.

That's one of the taskings we've given Team Mike that I mentioned. We have a long way to go. We are working with the DMSO (Defense Modeling and Simulation Office) that's been formed and I'm a member of the steering panel within that organization,

to try to determine protocols, interface requirements, and how best to get on with modeling simulation and wargaming business.

The integration of power projection forces, I think, including Tomahawk needs to be played out better in the simulation process. We learned in Desert Storm that the ability to employ TLAM was frustrated by our ability to figure out how to integrate it with airborne forces. Time-over-target considerations, routing considerations, and so forth, are part of the problem. We have a system that we are attempting to integrate some of this into, it's called ENWGS (Enhanced Naval Warfare Gaming System). We have taken some of those terminals which are strictly desk-top-type computer terminals and they have been installed at JWC. If we can figure out how to internet our wargame system and exchange data base information, we will enhance our joint training efforts with Army, Air Force, Marine Corps, and Navy. We hope that will give us some backup, but ENWGS is not our total answer.

We need to be able to take that *type* of system to sea and play ship-to-ship, ship-to-land, ship-to-CINC, commander at sea with the component commanders on the ground, and with a unified CINC on the beach, wherever he may be. I agree with the comment completely that was made about AWACS over south central U.S. playing with somebody in Norfolk, AEGIS or out at the AEGIS simulator at Wallops Island or Dam Neck, or out at San Diego at TRAPAC, or TRALANT at Norfolk, or the tactical training groups where we train the deploying battle group commanders, their staffs and subordinate commanders. That all needs to be internetted together somehow with the proper interchangeable protocols, or interchangeable data bases using standard protocols that we can all use. We need the ship-to-ship links and we need ship-to-shore links, the interconnectivity of how to lash all of this together and make it work. It doesn't exist today.

There's definite payback on the technology here. I see it in training, training benefits, force readiness during deployed operations, pre-flyover awareness, threat laydown, and to be able to fly against what appears to be the real threat in a simulation at sea with deployed forward presence force. I think it would provide the guy in the cockpit a better threat awareness of what he actually is to fight against. It would aid in ingress/egress routing. And it should increase over-the-target effectiveness. MOEs and COEAs were mentioned by the previous speakers--measures of effectiveness and the operational effectiveness studies or determinations that must be made now before we carry any program forward to the milestone process in compliance with the new DoD 5000 series and acquisition instructions. Very, very critical

The modeling and simulation requirements are going to be far greater, and imposed on us as we try to define requirements, carry those through the ORD process in the acquisition phase as we attempt to come up with optimum weapon systems. We are going to have to rely more and more on simulation and get away from trying to rely strictly on live testing. I don't think we should learn the wrong lessons from all of this. We very well could with respect to simulation if we don't take into account that the simulated threat we go against may not allow all the considerations we would face in actuality. I think a key one that needs to be looked at very closely is electronic warfare simulation.

There's another exercise that's about to start that Navy is trying to get some modicum of play in; it's called JADO-JEZ, the Joint Air Defense Operations and Joint Engagement Zone exercise. It will take place out west in the not too distant future. We've been able to get at least one Navy guy on the control team along with involvement of naval assets. We want to carry that project a step further and try to figure out how to bring in the land/water interface in air defense or air superiority type considerations.

In summary, everything that's being done here, I think, in the technology arena certainly feeds our way of thinking in the Navy as to the direction we think we need to go. I certainly concur with the comments regarding joint training. Perhaps the Navy has played its own game a bit hard in the past, but I'm a firm believer in joint training. I wear a purple suit, and I mean that from previous duty assignments. We need to move forward in defining joint training requirements and the interfaces that must take place to better achieve jointness in the future. So you see, everything that you're doing here is valuable to us, and I certainly support what you've done. I mentioned the importance of internetting, the importance of protocol, joint training and the MOEs and COEAs, and I believe all of that plays together. I will carry the message out of here--what you are doing is extremely important and it certainly plays in all those arenas. Thank you very much.

MAJOR GENERAL MATTHEW CAULFIELD, USMC

I was wondering why you asked a Marine to be part of the panel until it dawned on me it's an hour and 20 minutes after lunch and I'm the fourth speaker. (Laughter) As you know, Marines are fearless, but it's a little unnerving looking at all of those other green colored uniforms in the audience until the lone Marine Major walked in. A little late, which we'll talk about later. (Laughter) General Gorman told me you civilians are "a bunch of bright guys from laboratories and places like that." Talk about giving a Marine paranoia. (Laughter)

More seriously, I would like to say something to the Army officers present. I was involved in requirements for the Marine Corps during Desert Shield/Desert Storm. Much has been said about "jointness" but there are few better examples of it than the support the Army provided to Marines. The Army reached deeply into their equipment bag to provide M1A1 tanks, combat excavators and a host of other assistance. We also appreciate being included in the demonstrations conducted at Fort Irwin.

I hope to be very brief. Almost everything that I wanted to say was said by Generals Welch, Thurman, and Gorman. General Welch summed up the Marine Corps interest in SIMNET simulation: "we want to know what these kinds of things do and what they don't do."

I am awed by Easting 73. It's impressive. The performance of the second ACR was exceptional as is the way IDA and the Army were able to apply advanced technology to do what the U.S. Army has always done relatively well: record battlefield history. General George C. Marshall had a particular interest in history. The history program in WWII where historians accompany combat units and the volumes that were written at the end of the WWII are classics. I remember meeting General Matthew B. Ridgeway long after he retired. He was reading a manuscript on the Manchurian War in the 1930's, written in 1945 by Japanese officers at the behest of General MacArthur. It impressed me that a retired soldier was still reading about, and still learning about, war. Easting 73 would have impressed him.

Easting 73 fits with that tradition and makes the study of war more effective through the use of technology. However, I want to emphasize that it does not replace, in any way, the lifetime of study required to have the privilege of commanding Americans on a battlefield. And in spite of your commendable efforts in the use of technology, there is no way to replicate precisely a battle. Advanced technology permits PKs and PHs to be more accurately portrayed; to analyze variables better. But it does not give a computer program which precisely replicates battle for the young officer, the student of battle, or the soldier learning to lead. Easting 73 does not include the enemy, a major flaw. It concentrates on effects which may lead to false conclusions. What about morale, relative training, relative leadership? The reason a fighting vehicle *was not* destroyed is as important as why *it was* destroyed. What made the difference? What was the enemy/friendly mindset? The list is endless and all of the criteria cannot be programmed.

General Thurman said, "*some* criteria on effectiveness of the enemy can be ratcheted up." That's true, but not all criteria. General Gorman made a point that if we could crank in "what ifs" we would really have something. I agree. I'm not familiar with

the Livermore model but if you could do that, if you could "what if" a different weapon system, "what if" a different enemy, and so on, we would have a tool which would revolutionize the study of battle.

One other point. The model does not replicate the effect of synergism produced by supporting arms. Air support isn't in this model. The synergistic effect of supporting arms is what the future battlefield is going to be all about. If I'm correct, then the model doesn't include one of the most important criteria of future battlefields.

I am looking forward to your questions.

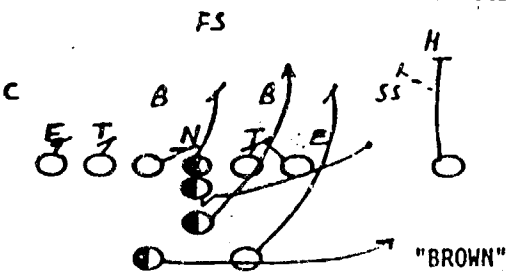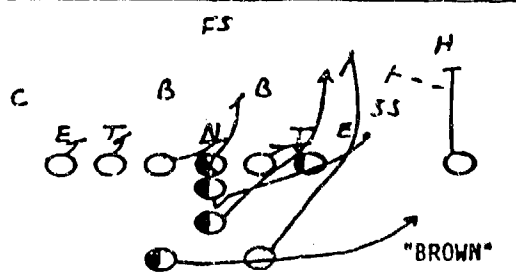## BRIGADIER GENERAL GERRY GALLOWAY

# Reliving History

Preparing to Make History

Slide one. I was given the mission of talking about education, as the wrap-up speaker. I wouldn't say the clean up-hitter, after looking at the distinguished gentlemen who preceded me. I'd like to talk a little bit about reliving history and preparing to make history and how simulation might fit into the business of what we do at the Military Academy.

In education, we are in the business of understanding relationships. I think it is important to recognize there are human relationships and physical relationships. Some of these can be easily defined; some of these are not so easily defined. We spend a great deal of time trying to define the fundamentals, the principles and the theorems in order to provide a structure for our future decisions. There are many tools that help us define these items. In the study of the history of the military art, we have found many of these tools and they're called books. But these tools haven't changed very much over the years, and, as in many other institutions of higher learning, we know that change is important.

Slide two. Let's get to the fundamental element of college, football. This happens to be a play out of the Army football playbook. Why do I show it? Because football is equivalent to war. You have young people engaging in a modified form of combat. This is a play. What do coaches do with this sketch? Coaches draw a play on a blackboard. Then they go outside and rehearse it. In days of old, they critiqued it by going back to the blackboard and showing the players what went wrong. Long ago coaches gave up that approach. What do they do today? They watch with video cameras (although NCAA restrictions prohibit them from using video during a game) and critique the effort using the videos. In practices, they run the scout team, the OPFOR, against the team and tape the action. They are critiquing every play. They are learning the fundamentals. They are dissecting the action, trying to understand the basics. They do this review quickly, and as a result, they are able to make changes rapidly. The players understand what went wrong, what theories and fundamentals were violated. They *see* how they can improve. Well, we need to be moving the same way in education--away from X's and Y's on the blackboard and on to video representation.

PLAY: __66/67__   SPLIT: __WIDE__

POSITION	ASSIGNMENTS AND TECHNIQUES	COACHING POINTS
LEAD BACK:	Seal LB-ROV-FS (on BROWN, GREEN, PINK)	Be Aware of tight scrape LB. Always go outside #3 on seal
PITCH BACK:	Pitch course maintaining relationship w/QB. Pitch will be off ? zone defender.	Relax inside shoulder. Get out in front of QB

Slide three. This is a map of the battle of Antietam. I was thrilled to hear that Colonel (Trevor) Dupuy is working on an analysis of this very battle. We teach the battle of Antietam using viewgraphs as training aids. Instead of using a paper map and a sandbox as they did in 1877, at West Point, we have gravitated to viewgraphs. Now, I am not putting the approach down; however, we are moving ahead, as I'll show you in the next slide. In most service schools, where we teach about warfare, we teach about it using paper maps and viewgraphs. During Desert Storm, the basic tools were still the map acetate and the grease pencil. But, you all recognize, after two days here, that much more can be displayed using some form of automation.

ANTIETAM BATTLEFIELD
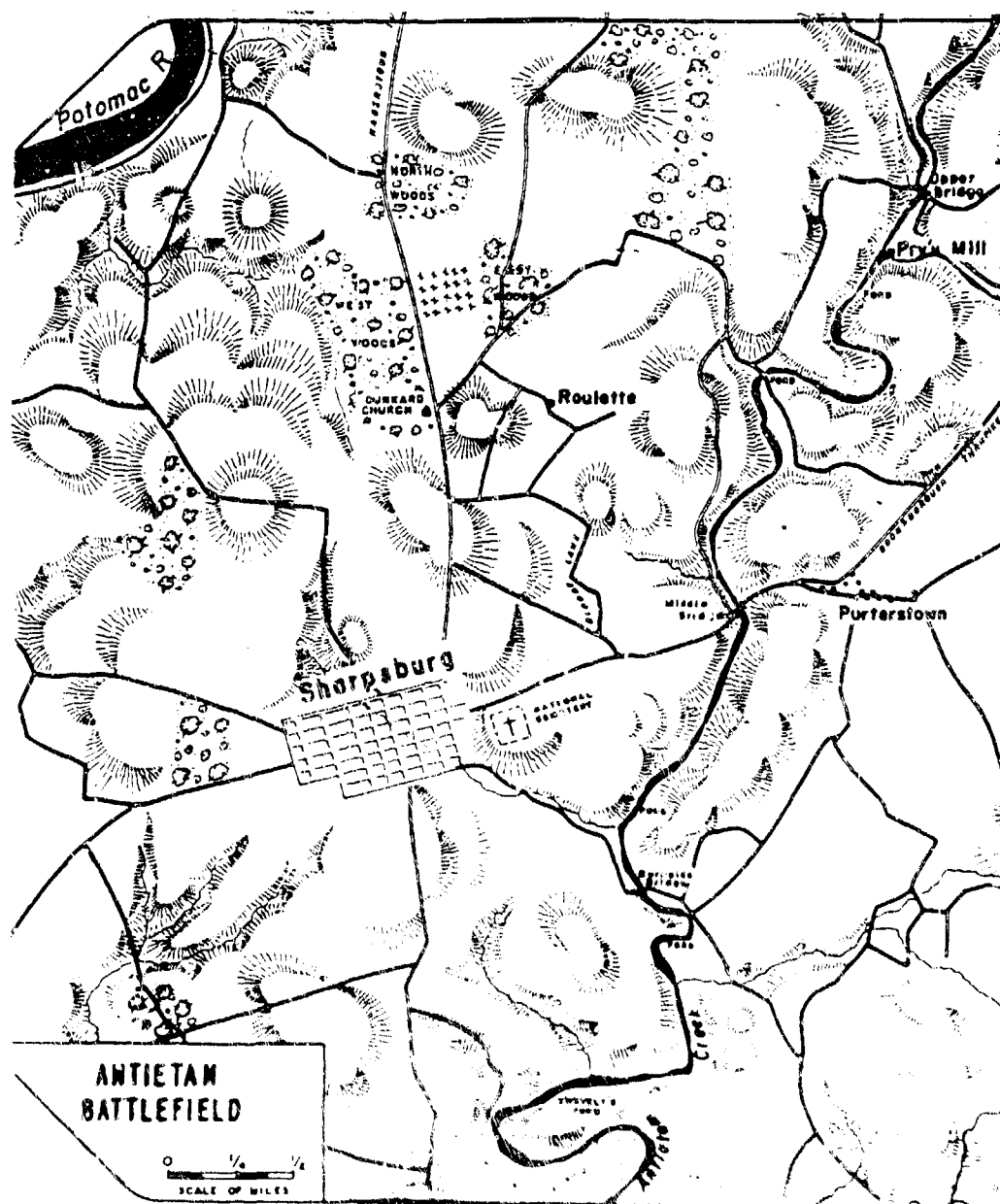
Slide four. This is an extract from JANUS, a simulation that many of you know. We're using JANUS in our operations research center and in some of our systems engineering courses. JANUS has allowed us to create a dynamic battlefield; to show change over time and to deal in "what ifs." In the upper left corner, the square represents an innovation being evaluated, by some cadets and officers. It is an airborne screen that would detonate artillery shells in the air--break them up before they hit the ground. You might laugh about the approach, but one great thing about being 17 or 19 is you're not hindered by the constraints that many of us older folks have as the what can and can't be done in the future. And so, use of simulators gives us the opportunity to do "what if."
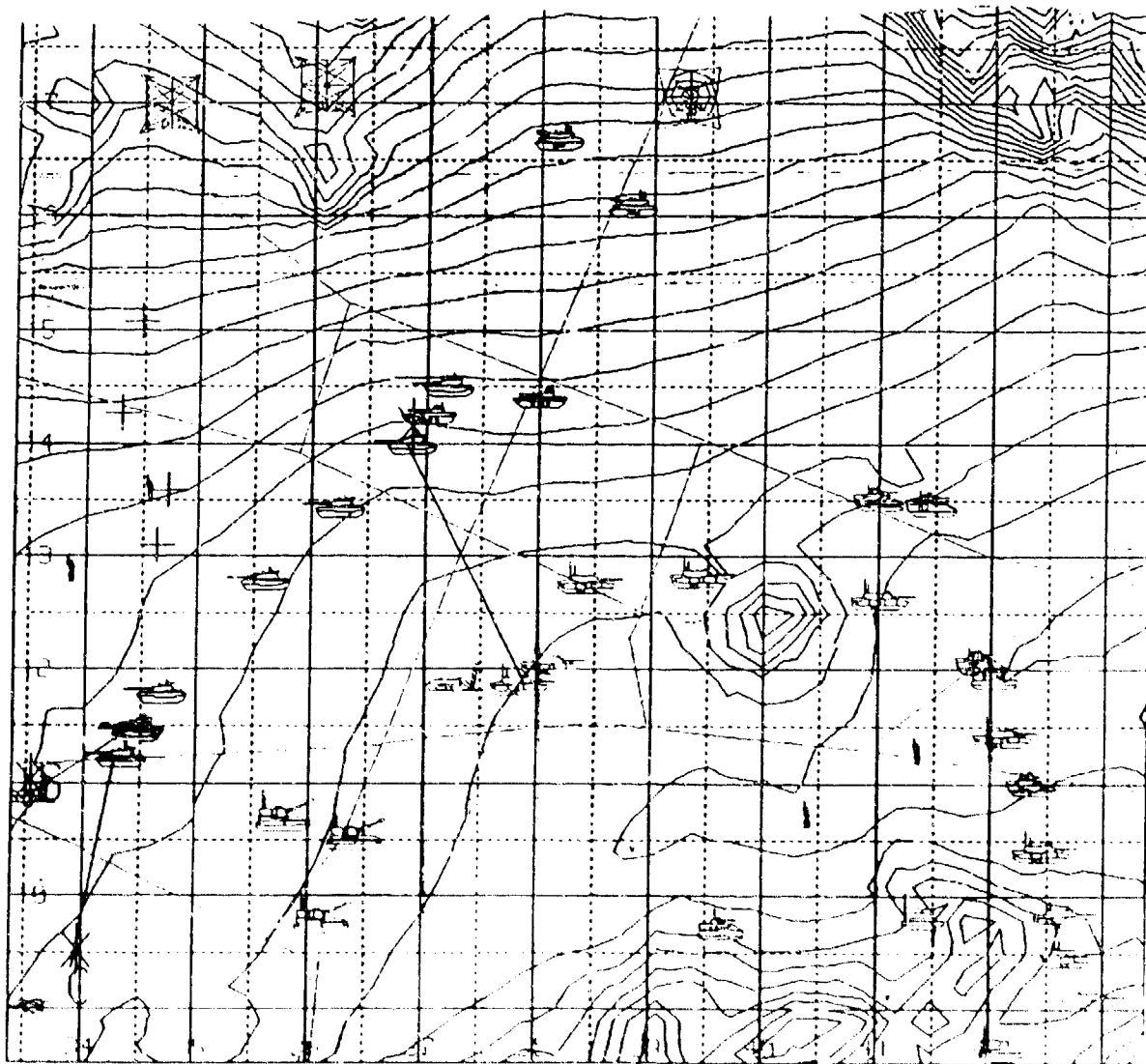
But, what's wrong with JANUS? We've learned in the Army, at least I have in my 34 years, that try as we may, we cannot get people to see terrain rise up from the paper. The third dimension is just not there. 2-D is good and a very skilled leader will be able to interpret that map and "see" the terrain. But for many, that visualization is just not there. So we do need the third dimension.
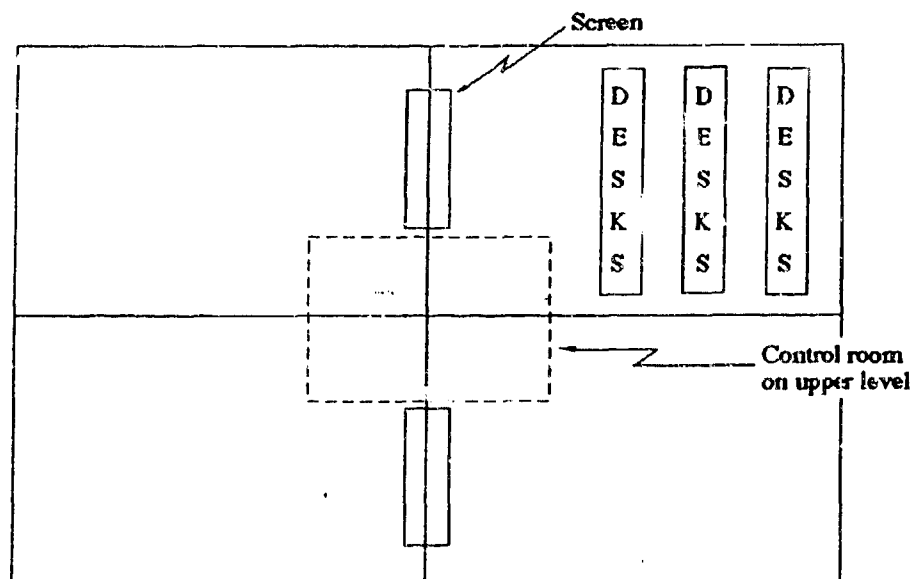
Magic Carpet Classrooms

Slide five. Wouldn't it be great if we were teaching military history to have a sim center with four classrooms, each with a "magic carpet." So when we would talk about the battle of Antietam we would watch people move across the battlefield. Instead of having little red and blue symbols moving around and instead of having the students trying to visualize the spatial relationships, we would have them watching this "video." Are the troops of the enemy in defilade? They might catch that on a topo map, but probably not. When you think of the realism that we've seen here over the last two days, what people have with SIMNET, you recognize there is another dimension to that learning experience when 3-D simulation is involved. We can do just what football coaches do today, relive history by looking at it. In reliving it, we can understand more of the fundamentals, the theories and principles involved.

We believe that in moving to automation, we move into better education. With simulations you may learn more about people, more about equipment. The people dimension is an important one. The 2-D models show you what it is to fire from one tank at another. They may show you which tank is killed, but they don't show you the stress on the individual. I was never more amazed and never more impressed than when, out at

the SIMNET facility at Fort Knox, I watched young soldiers get out of their SIMNET boxes soaked with sweat because they had been so involved in this artificial battle that they suffered stress.

You cannot simulate battle. There is no question about that. But when you are working in a small unit and you are working with your peers, and you are working for success, something like the system that we've seen over the last two days can bring that human dimension to bear in a way no other simulation can. We see great need for this simulation. We see that we can work, not only in our own classrooms, but also in the classrooms of others and share our experiences. What if ROTC detachments around the country were linked to West Point by network? Our military history group could export a particular battle to them. What if we did it with the Air Force Academy, or the Naval Academy? We could begin jointness early in a military career.

But enough learning about the past. What about working for the future? Generals Thurman and German have both mentioned our success in training. Our young people expect good training. They live with Nintendo. They live with modern technology and to give them simulations that offer less than what we have here is not giving them the potential to be all they can be. Showing our young soldiers on a map how an armored vehicle attack might look on the ground will not do it. Give them the opportunity to "simulate" the attack. Take this same approach with our junior leaders--our NCO's and our junior officers- and benefits multiply. They can be given the opportunity to make mistakes on the simulator before they move to the field. They're going to make mistakes. Trying to minimize mistakes and giving them greater confidence makes sense. The opportunities to practice for the future in the battle command training program, in field exercises at the National Training Center, and in the simulations we've just seen give you great training. I have seen a corps staff arguing in front of their commander over what was done in the simulation. It was, to them, very, very real. And imagine if they'd just been through something like the 3-D simulation of 73 Easting. There's a great role for this technology in education. We see, as General Thurman noted, the power of technology. We're not sure of how we can exploit it, but we know it needs to be exploited. It may not be tomorrow, it may not be the next day, but I will tell you, we at the Military Academy are planning to have this technology in our classrooms in the future. We'd invite you to participate with us in what we think is going to be a great experiment in improving education and moving high technology into the training and education world. Thank you.

DOUGHERTY: I'd like to open the floor to questions.

Q: You said this technology might be useful for education. Do you think re-creating battles in history with this technology is possible for historical battles, battles of the past, for which detailed information like the 73 Easting data is not available?

A: (GALLOWAY) Well, I think that Colonel Dupuy would make the case that you can go back and look at our civil war battles and have a fairly high degree of confidence as to where people were at a given point in time. They have fairly good records, and in many cases, in the years following the war, they went in and gathered extensive data on time/space relationships. Now, what about World War II, what about the Napoleonic campaigns--I think you would begin to gain insights rather than detailed understanding. Those insights are important. And the terrain does not change except at Waterloo, where we built a beautiful mound so we could look at the terrain we destroyed. Those sorts of things happen when you have tourists and other human intervention in the landscape. Yes, I think it is very useful in history, to be as accurate as you can be, to know more about a particular battle. But if you're dealing with principles and fundamentals, I think it's really the essence of the battle that you want to re-create, rather than the specifics.

GORMAN: I vote we listen to Trevor Dupuy on that point, Gerry (Galloway). Do you want to walk up to the microphone, sir?

DUPUY: I wasn't expecting to be called upon, I appreciate the opportunity, but there is no question that there is a great deal known in great detail about a number of battles in history that is approximately correct. Particularly, battles in WWII where we fought against the Germans, where the Germans kept good records, we had good records, and the possibility of re-creating some of those battles is beyond a doubt available to us. To utilize this technology, which is one of the most exciting things that has come along, as far as I'm concerned, in years, would give an opportunity for training and education in a way that would make the training so valuable, so professionally inspiring to young officers, that I think we've got to move to make the maximum use of it as soon as we can. I can't speak too strongly in endorsing this particular relationship between technology and history. I think this whole meeting, and if Colonel Thorpe is the man responsible for it, he has got to be given great credit, is an historic meeting. And so I congratulate everybody who is responsible for it. Thank you very much.

GORMAN: That's from one of the premier military historians of the United States, and indeed, of the world. That was a pretty strong endorsement. I would add to Gerry's point that one of the advantages of simulation for these historical educational purposes is

exactly that the simulation is not bound by the works of man on the contemporary terrain, and you can look at the terrain as it appeared to the commander at the time. I would much rather visit Waterloo in simulation than in its present state.

Q: A question for General Thurman: the issue we try to tackle, I guess is to get a balance when it comes to the training utility of simulation and I guess what we're really trying to shoot for, is we want to get vaguely right and not precisely wrong. And yet in the development process of this both from the engineering standpoint and also the training standpoint, there is this tendency to have what I would call an engineer's mentality that picks at it and says, uuh, it's not right, it's not quite there yet, we've gotta add another dial to this, we have to have another task to do that so we keep spending a lot of time and effort and yet don't get the efficacy of the tool out into the field. How do we do that, how do we institutionalize that from a training perspective and move on so we can continue to be creative in the R&D cycles?

A: (THURMAN) Well, in two cases, one which I would call the battalion commander's tool, which we use now at Leavenworth is simply issuing a relatively modest order to have it done in about 90 days. So that took out a lot of the engineering corruption that was in it. But the notion behind that whole thing was taking stock of the fact that the average battalion commander was only going to get a chance to put the full repertoire of his battalion and its components on the field, two or three or four times in a two year period of time. You say then, if he was a chess player, would he only practice three, four, six or eight times if he were going in an international chess match? The answer is clearly he would not, he would be doing hundreds of chess games a year. So you tell that to the guys at Livermore, who did the work for us on JANUS, to update it, so that the battalion commander, is now in a pre-command course, can in fact go through about 10 replications of a battalion at the National Training Center or other terrain. It's not precise, but it is good enough to cause the battalion commander's issuance of the order, understanding what happened, go back and try it again, because it didn't play out quite as he envisioned, because the thinking man's enemy was involved on the machine system. So I would say to you, I think the system we've seen in the last couple of days, the computer image generator, you could get very, very, very, very precise in the CIG (and we're going to get more precise in the CIG). But even the early elements of work with respect to the origin SIMNET-like technology that was up in "Knoxville" were good enough for a battalion commander to get the spatial relationships associated with working against an OPFOR and getting all his elements of combat power brought to bear. I don't believe that is overly

worrisome about people who were dedicated to getting the machinery in the field. I think that's more evolutionary than an impediment to getting it quickly on the street.

GORMAN: I'd like to take you back to a point that Paul Funk made in his opening remarks...I mentioned the Louisiana maneuvers as a way of training senior commanders. We now do that training today with constructive tactical engagement simulation, with models of combat. We know those models are not a wholly accurate replication of battle. I mean, I think every one of us who has ever played with one of those models can identify areas in the model that we simply just don't believe. On the other hand, they do clearly stress a commander, and they stress his staff, and they teach battle staff integration. We've demonstrated that in a variety of ways. We also know that those teaching experiences bring about improvements in the performance of the battle commander and staff as measured by any of a variety of traditional or behavioral measures of effectiveness. So even a fairly inefficient or ineffective model of combat, properly applied for training purposes, can make major differences.

This is the telling point: twenty years ago, the Army would not have been able to get its Corps commanders to submit to the discipline of playing a war game under the conditions that are now routinely used in the Battle Command Training Program. Twenty years ago there was no effort being expended of the sort that Max made reference to, that prepares battalion commanders through vicarious combat, if you will, for the responsibilities they are about to assume. The more closely we can approximate the exigencies of combat, the better those training experiences are going to be for commanders and the more efficiently they will use the forces and the people that are entrusted to them. I would submit that understanding close combat through the mechanisms that we're discussing here--to be sure submitted to all of the wisdom that we can bring from historians and analysts--will make available to U.S. forces of the future even a greater assurance that they can do the job quickly, against long odds, and with minimum casualties. Perfection of the simulation should not deter us from getting on with doing just that.

CAULFIELD: I could emphasize that really quickly. This is particularly true in future fluid battlefields. When commanders give mission orders and have to believe that their subordinates understood what they said when they intended something--which comes not at all easily, and one very, very good way to do it is the kind of simulation that the general just referred to.

WELCH: From another perspective, I think it's also important to define what you expect of the simulation. It is difficult to get the tactical air forces interested in SIMNET

because fidelity of the A10 simulators in SIMNET was so lousy that Tactical Air Command felt it didn't teach A10 pilots anything. But the fact is, it did. The purpose of SIMNET was not to teach A10 pilots anything about flying the A10.

THURMAN: Now there's a mud fighter for you.

WELCH: What an A10 flight leader needed to practice, needed to understand more--needed to get out of the simulation--was how to work within the system, how to bring the A10 to bear where the air/land battle called for A10 support. SIMNET could do that very effectively. So the initial understanding of what SIMNET ought to do for the tactical air forces was faulty. There was this great demand for increased fidelity in the simulator itself. In my view, that totally missed the point. You need some simulators that have high fidelity but only some purposes demand high fidelity. So at the outset, the proper definition of required fidelity is important in preventing over engineering.

GORMAN: I took a very senior Air Force officer, who will remain unnamed, down to Fort Knox, and he flew one of the A10 simulators. I then heard shouting and yahooing back in the box where he was doing his thing. Finally, he came out, covered with sweat. I asked, "How did it go?" and he said "Just went great. I got to take on some T-72s and I won 2-1/2 to 1." I said, "How do you win 2-1/2 to 1 in SIMNET?". He replied, "I killed two with my gun system and I flew through one."

THURMAN: Let me give you a BFO (blinding flash of the obvious). You see, most battalion commanders have not been battalion commanders before they became battalion commanders! That is a maxim, OK? It's sort of like the story that half the people are in the upper half and half the people are in the lower half, and we find out that the top 50 percent are in the upper half! The point I want to make, in the battalion commander game, is up to that time he becomes a battalion commander he's been the S3 or the executive officer or a company commander but he hasn't had the full panoply of systems to bring to bear on the battlefield that he does as a battalion commander and then pay the consequence for it. Therefore, it doesn't require or didn't require absolute fidelity with everything in order to give him these sensory skills about time and spatial maneuver with his own stuff against the time and spatial maneuver of the OPFOR on that. The power of the machinery that we have coming up is that, in the combat developments world, we're down there screwing around with the PK to the point of distraction. But you see the problem is the troops aren't getting that kind of PK out of the thing in the field. And the real PK for a particular system may be what is actually being seen on the battlefield and landscape at Fort Irwin, California. Now to the degree that you can spin that back into

your modelling system, is to the extent that you then are representing. You may have bought the weapon system for performance up here, but it's actually performing here. You can disect why it isn't getting the full value out of it and you get a whole lot different effects coming out of these kinds of systems that we have, and are currently sort of separated systems of combat developers from the training side.

Q. Doc, I think I would like to address this question to you as head of the panel. I'm Al Stevens from BBN and the first thing I want to say is I very much agree with everything I've heard the panel say today. I cannot endorse the kind of statements I've heard any more strongly than that. I want to express a certain amount of frustration, however, I've heard those statements now for about three years. General Thurman, I've sat in your office at Hampton Roads nearly three years ago, and, General Gorman, I've heard you talk and make these strong endorsements of this kind of technology over the last 36 months at least. At some level, for me, the technology has achieved a level of face validity and yet I see the U.S. Government having a very difficult time figuring out how to go forward with it. While on the one hand you can go and look at an army aviation master plan and see how the steps are laid out from getting from one helicopter to another, it's very hard to find any one or any place where you can look at the DoD, the Army, the Navy, the Air Force vision for the application of simulation technology. I happen to do a little bit of traveling, I go to Germany occasionally, I go to Japan occasionally. The German government has at this point announced to industry, the BV/B, the German procurement agency, has announced that all simulators shall be networkable. They are requiring that. So all of German industry is working hard at figuring out how to make simulators networkable. The simulator you mentioned in defense news, my gut doesn't tell me it wasn't networkable, I'm sure it wasn't networkable. It was not a requirement, we are not seeing that. In Japan, you see the Japanese ground self defense forces, Japanese defense industry, and the phone company all working together to establish a standard, laid on top of their fiber optic system that's going in now to allow the interconnection of simulators. If they are that forward in their thinking, they have a five-year plan laid out for the use of distributed simulation technology to develop a combined arms and weapons development capability over the next five years. I, as a member of industry, don't see where that kind of leadership is coming from in the U.S. Government. I think DARPA, in the person of Jack Thorpe and others, has provided a strong initial set of leadership to get this all moving. What I'm trying to figure out is, where is it coming from after this, what role do you see DARPA playing, what role do other members of the panel see the Services

playing, and where do we, from the industry side, look to for the leadership in bringing this kind of simulation technology to fruition in this country?

Comment from audience: "Make it competitive."

A: (GORMAN) In the Acts of the Apostles there are a number of plaintive passages, like those that were just delivered; 36 A.D. is just a little bit early to look for the conversion of the world.

A: (THURMAN) General Welch has agreed to take on your project. He told me he had 500 professional man-years to turn to it.

WELCH: That comment is punishment for the Air Force's foot dragging on this while I was Chief of Staff. Let me say a bit more about that, because I think there are some important insights. In the first place, for anything like this to move forward, it has to produce a critical mass of supporters. And I think that has occurred much more rapidly than is usually the case. There are a number of things that have happened in the past two or three years that I think ought to give you some hope. In the first place, the director of DARPA frequently gives speeches that say he has three priorities. Simulation, simulation and simulation. Secondly, the very name SIMNET has been a bit of a problem. Because SIMNET, in the minds of many people, is that training thing down at Fort Knox--which is very valuable, but that's not what we're talking about. We're talking about advanced distributed simulation of which SIMNET was an early example. The 73 Easting effort will attract a lot more attention to this capability. Then there is DMSO. It doesn't matter why the DMSO office came about, it may be in some respects a child of Congress, but now it exists. There is a lot more pressure, from a lot more OSD offices who make decisions on these systems, that will demand a greater use of these kinds of simulation techniques to support decisions on everything from training systems to weapon systems. I don't deny that there is reason for frustration about the pace, and the lack of standards and the lack of interface definitions, etc. The fact is, within the U.S. Department of Defense, that doesn't happen by decree. And you could lay out a fixed Japanese-style five-year defense plan till hell freezes over and it wouldn't make things happen in the U.S. Defense Department. What makes things happen in the U.S. Defense Department is a critical mass of opinion that this is important and ought to be done. It takes time to build that. But I think you will see that building rapidly now.

Q: (GORMAN) Is the Deputy J3 in the audience? Or did he leave?

THURMAN: To take a quote from history, somebody said that the body politic obeys Newton's second law very well. A small force exerted over a long period of time will bring everything up to speed. And you can hurt yourself severely if you try to do it with an impulse. So time is perhaps one of the most important factors in bringing the commonality of the interface standards and the community to a common set of understandings.

STEVENS: Yes, I certainly believe that but, perhaps, I'm young enough to remain impatient about the process and some of the frustration comes out. It needs to happen.

GORMAN: You are the stuff of which martyrs are made.

STEVENS: I know better than to engage in a verbal battle with the two of you (Gorman and Thurman). I do want to express my interest, industry's willingness to help it happen. And when I speak to a lot of folk in the government, I feel the same thing. I do believe this conference is an example of kicking that kind of process off and moving along. I do, firmly believe, that the U.S. Government maintains a critical leadership position in this technology, and I believe that we can maintain that leadership if we move along quickly in a planned, careful way. And would very much like to see that happen.

GORMAN: One of the constructive responses that I think we could make would be to urge on General Funk, the Deputy J3 (who is now seated in the back of the room) recourse to mechanism of the Joint Requirements System. My colleague to my right, General Thurman, used to sit on the JROC panel. The Goldwater Nichols legislation put the JCS into the material requirement business and it strikes me that this is a *prima facie* case for the Chiefs to articulate a requirement for moving joint training into the 21st century.

The remarks of our panel would communicate to you: A: This is urgent business. B. It is joint business. And C. It bears directly on the kind of strategic environment that we face in the future. We need to build the forces that can be trained to cope with a wide range of contingencies, as opposed to the canonical threat to Central Europe. And there is no prospect that we are going to be able to do that except through recourse to simulation.

Dr. Stevens, you're absolutely right: unless and until there is an articulated requirement for a common standard that permits the communications among various forms of simulation, from Service to Service, from weapon system to weapon system, from one type of warfare to another, we are not going to be able to make much progress with joint

training. And Title 10 U.S. Code lays on the Joint Chiefs of Staff legislative responsibility for the joint training of the armed forces of the United States.

Q: One of the great strengths of this kind of system is its realistic representation, or apparently realistic representation, of what the warriors might be seeing. Paradoxically, I wonder if the clarity of this representation in its seductive nature may not be one of its greatest dangers. Underlying any sort of system like this are mathematical models and algorithms and what's concerning me and I would like to address this to the panel, I'm wondering if you feel there is sufficient dialogue between the technical developers of these models to understand their limitations and the degree to which they can be applied and the decision makers who have to use the results.

A: (THURMAN) I believe, as General Welch eloquently expressed, you have to define what it is you want the simulators to be able to do for you at the get-go. I was impressed when I went out for the first time, since I'm not an aviator. I'm not rated. I flew a 767. I flew it from the Seattle, Boeing, field down to L.A. and landed it. And after I landed I drove it off onto the dirt and imprisoned it in the soft dirt there! And I asked a guy do you really believe in this simulation and he said "yeah, we're pretty comfortable with the simulation," he says, "the first time a guy drives a Boeing 767 for real, you'll have a passenger in the back end, paying passengers." I think the simulation world is quite good enough to give you whatever you need to have out of it. And people can, in fact, learn what it is that goes on in tank engagements. And that is to say that, I know in the previous work, I think Jack would attest to it, we put engineers in the tanks and they got a chance to experiment with the tanks to figure out what tanks are doing and were therefore able to replicate them with reasonable accuracy. So I would suggest to you that, I believe, there is a good enough interface between the worker bees and the services and the worker bees and industry to be able to get a reasonably valuable simulator out of it.

A: (FUNK) I can respond to that a little bit too. I think you almost have to ask yourself where were you before the simulator, where were we before we bought a thing called combat firetrainer. We were going down table 8 just as an example and trying the exercise once, maybe twice, a year if we were lucky with the simulator, which by the way doesn't have 100 percent fidelity for the gunner and commander, in terms of what you see In other words, even though you can make it dark and you can blow a little smoke and haze out there, the tank looks a little funny compared with what you see in the sight in the real situation but the fidelity is high enough and the kid is smart enough, he isn't being fooled by that. That this is not the real world. I look back to when I was a tank company

commander a year or two ago and then think about now when my son is a tank company commander does in the training of his people and there's no comparison. It's the training system we talked about yesterday, but it's also the devices we had. Usually the training devices went in the corner, they were lost and thrown away. You couldn't really use them because they weren't really close enough in fidelity. Now they are. Now you can talk about the distributed system doing things at the joint level with all kinds of staff officers who cause those things to happen anyhow they don't see the battlefield anyway, not really. So you can re-create it electronically. As long as everybody understands that the result in combat may be different as long as performance is based upon a set of standards to get us better at what we know we have to do, then I think the unknown is less fierce. I think that's the way I would answer that question. We're a long ways beyond what we were twenty years ago.

Q: I would like to ask a question based on one of Admiral Allen's comments earlier. What we see here is a re-creation of a battle that was basically a visual battle. One which was limited by the environment but essentially the combatants engaged each other due to a visual type of scenario. Are there any plans to extend this to beyond visual range to the EW, IR sonar type of engagements?

A: (DOUGHERTY) One of the things that DARPA is planning for its simulation program in the next year is to develop more thoroughly the electronic combat environment. That's an extraordinarily difficult technical feat. Because one has to look at both the receiver characteristics, the transmitter characteristics, primary noise sources, background noise sources, jamming, broadband, narrowband, specific pulse characteristics, interpulse modulation, the timing, the criticality, the redundancy, the encoding, and the capabilities of the individual systems that are playing in the battle. In addition to that, you'd like to be able to play the real radar characteristics of the targets. As we increase the LO (low observable) content of both airborne and surface systems, the real radar characteristics become essential to having the correct characteristics to model the behaviors that you see in terms of outcomes of the battle. Yet the desire is to keep those parameters that represent the LO characteristics hidden. Not just radar, but acoustic properties and visual and IR as well. It's a very, very difficult technical challenge to be able to integrate the RF world into the simulation world in such a way that you have the correct system level behaviors. That's one of the things we're undertaking. Second, in the acoustic arena, we have two proposals to build underwater models that give us the capability to simulate large ocean areas so that we can correctly handle both the surface and subsurface elements of

submarine stealth and ASW. And our surface warfare is a piece of that. How one plays that game in context of the other systems is TBD. There are enough challenges just figuring out how to model the sea, how to model the acoustic environment, and how to handle both the active and passive elements. Again, these are questions that we need to have technical answers to before we begin to integrate them into the larger network environment of the joint operations simulation that we want to move toward. We do have both of those elements in our program for the next couple of years.

A: (GORMAN) These are issues, I would point out, that can best be addressed at the theater of war level. Theater EW, planning, etc. And therefore, I would hold that General Welch offered the key to approaching the problem: the U.S. ought to have a model theater of war, to which we could bring the mechanisms that Doc Dougherty just described for use with joint forces in training, test, experimentation, or whatever. And we ought to recognize that opportunities to evaluate force responses to various electronic environments may be crucial on future battlefields. Not everybody's going to be as inept as the Iraqis in that respect. Finally, the way not to prepare for the electronic future is to do it the way we did in Desert Storm: deploy a system like the JSTARs for use in combat without its ever having been employed in joint training prior to its deployment.

A: (WELCH) I would also suggest that electronic combat is an area where we are in absolutely in no danger of duplicating understanding. But IDA has a small initial task, just to describe the C3 CM effort in Desert Storm. There, unlike a lot of other areas, we're almost without BS filters on electronic combat. So multiple levels of simulation would be extremely useful in that area. We need theater wide application, more detailed simulation of the effectiveness of any specific system within a larger net, etc. As to the BS filter, if you ask for a tank that has an unrefueled range of 400 miles that can cruise at 70 miles an hour and carries 80 rounds on board, there are lots of people that immediately wave the BS flag cause they know that's not going to happen. Or, if you demand a supersonic airplane, that has a supersonic range of 2000 miles, you get the BS flag. But, in an electronic combat world, you can ask for almost anything, and some contractor will say, we can do that. Then we embark on the effort to do it lacking the understanding we have from years of experience in other areas of what's possible. So that's another reason why that's a particularly fertile area to do simulation at whatever level--the system operation level, or the system of systems operation level.

A: (THURMAN) Moreover, I would suggest that the environment tells us, we'll never be able to turn that stuff on in peacetime, in general. So the only way you're going

to get anything out of it is to simulate it in peace in order to figure out how to operate it in war.

DOUGHERTY: Thank you very much for coming this afternoon, I'd like to thank the panel for their participation.

--73 EASTING--

WEDNESDAY, 29 AUGUST 1991

--73 EASTING--

DATA ANALYSES

SPECIAL PANEL ON BEHAVIORAL/ANALYSES DATA

29 August 1991

Panelists:

Dr. Jesse Orlan ky, Institute for Defense Analyses (IDA)

Dr. Ed Johnson, Army Research Institute (ARI)

Dr. Richard Bronowitz, Center for Naval Analyses (CNA)

Dr. Jim Metzger, Dept. of the Army (ODCSOPS)

Dr. Randy Steeb, Rand Corporation

Mr. Paul Kozemchak, Defense Advanced Research Projects Agency (DARPA)

LCDR Dennis McBride, USN, Defense Advanced Research Projects Agency (DARPA)
--Panel Moderator--

LCDR DENNIS MCBRIDE - DATA ANALYSES

I am Lieutenant Commander Dennis McBride, Program Manager at DARPA, and I'm honored to chair a session this morning on Behavioral Analysis. I'm happy to say that I've managed to whip this distinguished group into military shape, and I would like to introduce them from your left to right. Beginning with Dr. Richard Bronowitz, who is with the Center for Naval Analyses, his academic record including Ph.D.s in mathematics, currently is director of Warfare Modeling Program and Vice President of Field Operations at CNA. By the way, while I have suggested topics for these gentlemen, I have made no assumption that they will take the topic that I suggested, so I will ask each of them to re-introduce their topic as they stand up. To Richard's left is Dr. Randy Steeb, whose academic background is in systems engineering, including a Ph.D. He has served the past eleven years at RAND and most of his work has been in simulation technology and its application. To his left is Dr. Ed Johnson, who most of us know as the Technical Director at ARI, as he has been since 1982. He is a member of all the usual and correct societies and has all the appropriate degrees. His interest is in how to improve human performance-- How to improve human resources in training and utilization systems. To Ed's left is Paul Kozemchak, who is a special assistant to the Director of DARPA, and his responsibility is for strategy and planning. In his capacity he works very closely with policy planning staff with the Secretary of Defense, primarily on technology and R&D issues in defense planning. Before he came to DARPA Paul was research advisor to the commission on integrated long term strategy, which was created by SECDEF. To his right, I just skipped over Dr. Jesse Orlansky, who everybody in the world knows. Jesse, of course, is associated with the Institute for Defense Analyses. Two spots down to the left is Dr. Jim Metzger, who is assistant professor at the University of Georgia from 1970 to 1975, which is one of the most distinguishing features that I could think, because I'm a bulldog myself. His background is in model development and application at AMSA and CAA. I will first speak by giving a few charts on thoughts and I will attempt to be a bit provocative.

SLIDE 1

YOU COULD READ AND REMEMBER <u>EVERY</u> FACT IN EVERY ENCYCLOPEDIA IN THE WHOLE WIDE WORLD ABOUT BASEBALL. BUT, IF YOU DON'T WATCH OR MAYBE EVEN PLAY BASEBALL, YOU DON'T <u>KNOW</u> BASEBALL!

BECAUSE BASEBALL, LIKE WAR, IS ESSENTIALLY...

First slide. You can read and remember every fact in every encyclopedia in the whole wide world about baseball, but if you don't watch or even play baseball, you don't know baseball. Because baseball like war essentially is...
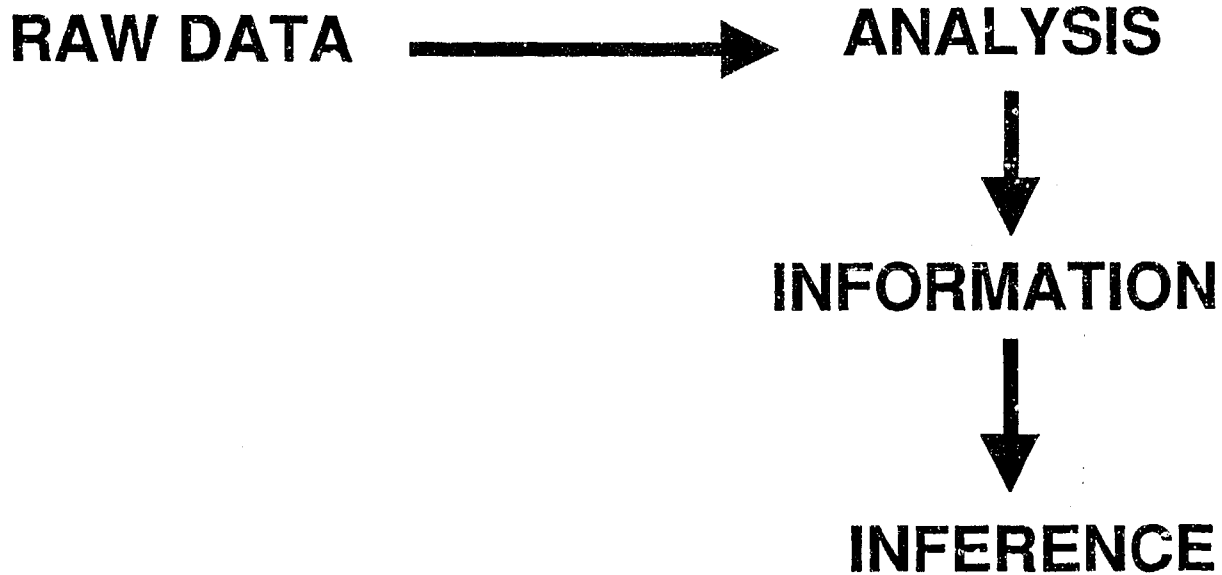
SLIDE 2

...BEHAVIOR

Next slide. All about behavior. I'll take it one step further. You can know all these facts and you could master all the facts from a knowledge base but you certainly couldn't play baseball and in fact, you couldn't manage baseball and I'll guarantee you, you can't win a world series. The analogy here holds fairly well because war is like winning a world series. You have to know the game, you have to know war. And thus, I make the case, that the simulation and reenactment of war is a brilliant way to understand and master the art of combat and the art of warfare.

Next slide. Typical inference process in science and technology goes something like this. We take raw data and we begin to try to understand it. There's typically more than we can comprehend at one time so we reduce, we systematize, we organize and we try to understand the data through a long process of meticulous analysis. From the data then, we attempt to produce information, that is we try to reduce qualified uncertainty about things that we need to know about. If we're lucky we are able to make inferences about the original raw data.

Behavioral Analysis

Inference Process

RAW DATA $\longrightarrow$ ANALYSIS

SIMULATION INFORMATION

ANALYSIS INFORMATION INFERENCE
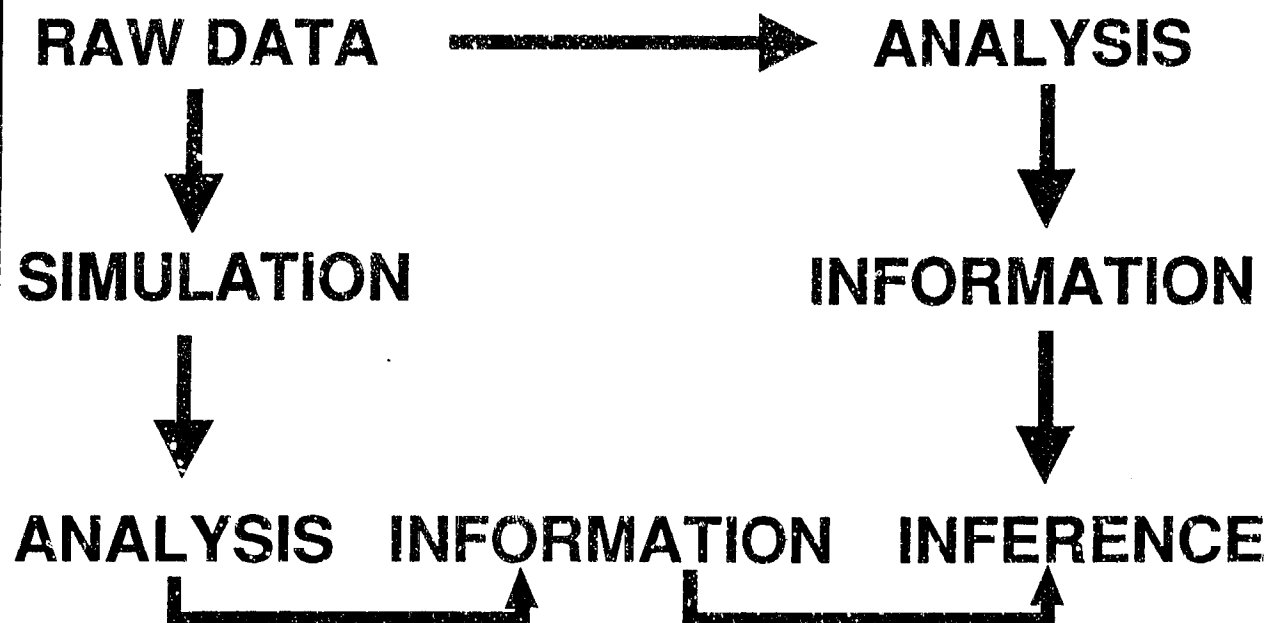
Next slide. What we are attempting to do here is to introduce an intervening process namely, simulation. And the idea down in the left column is that we can take raw data, interstitch these raw data into a process involving software that Andy Ceranowicz did a brilliant job of explaining yesterday. So that we can reify this process and watch it and produce analysis and information that we couldn't have arrived at had we not done the simulation. And that's the key point that I want to make. The derivation of information that we could not have known, nor mastered, nor manipulated had we not done the simulation. This introduces a new and I think synergistic way of providing the inferencing mechanism.
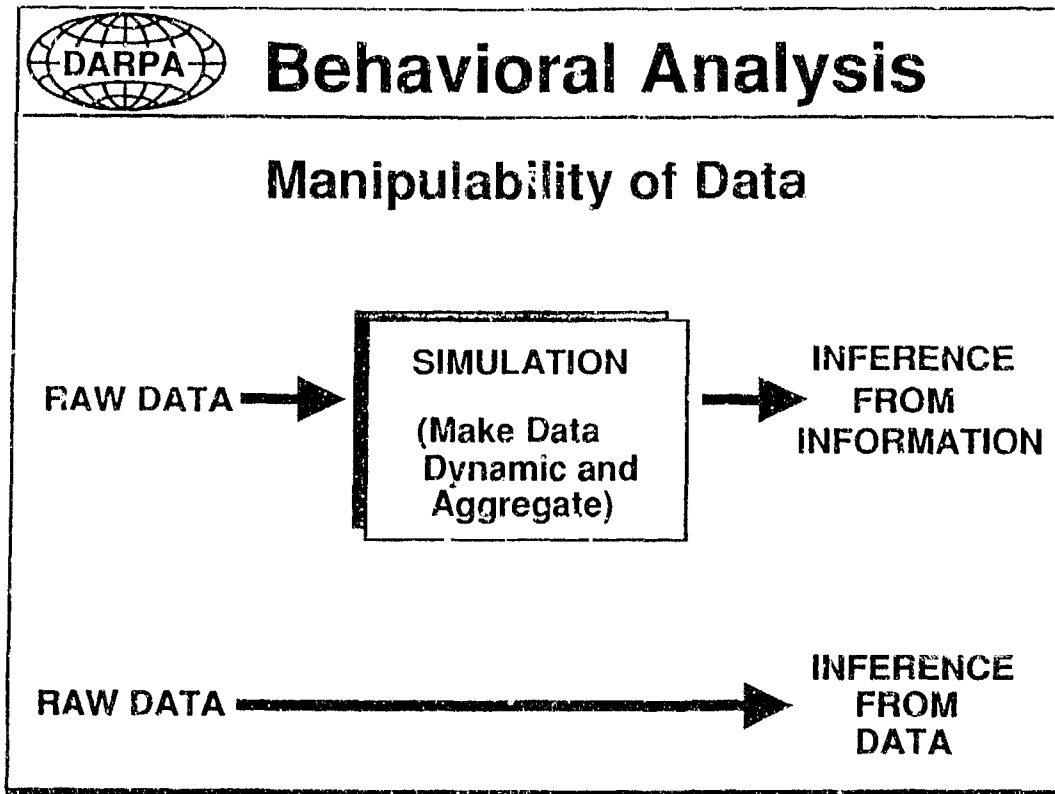
Next slide. Let me give a specific example and many, many come to mind. Let's focus on 73 Easting, or a similar battle, where we begin with a lot of raw data, reams and reams of raw data. These raw data, I compare to elements of battle. For example, what was the position of every vehicle at every point in time during the evolution of combat. We'll put these data into a model, into a simulation, which allows us to do this dynamic reification and we exercise it and we begin to understand from pictures and a mental mastery of what in fact transpired. We can then begin to analyze those transpirations as aggregates of the elements of battle. We now have pieced things together and we have a nexus that we can begin to see and understand. From this we produce information. For example, I can interrogate my system using a piece of software, maybe datalogger, or something like it, that will allow me to get a report out that says, what was the mean M1 velocity when firing. What was the average range when firing. And my contention is that these types of information could not have been derived from the raw data without putting them together to produce this dynamic reification. At least it couldn't be done very easily. And lastly, I'm able to make inferences about warfare. I may be able to see plainly through no more analysis, that speed superiority is a main effect of combat. And I use this as a typical example. But I don't want to stop here.

Next slide. I want to keep going. I want to take my data and my information that I've derived through the simulation, through the synergistic process and I want to do some statistical techniques. I want to do, for example, a hierarchical factor analysis, where I take my information and I decompose it and I begin to understand how my information relates to the first principles of war. As examples, I may find that velocity is an advantage, big surprise, I may find that armor is an advantage, or that logistics accounted for 33 percent of variation in my ability to sustain a force forward. These I refer to as factors. These are statistical factors and they are confirmatory. They say Sun Soo, you were right about this element of warfare. I don't want to stop here either.

Behavioral Analysis

Continued

INFERENCE

↓

EXPERIMENT

(Manned)

⇓

1. Velocity x Armor

2. Logistics

MAIN EFFECTS
INTERACTIONS

Simple effects
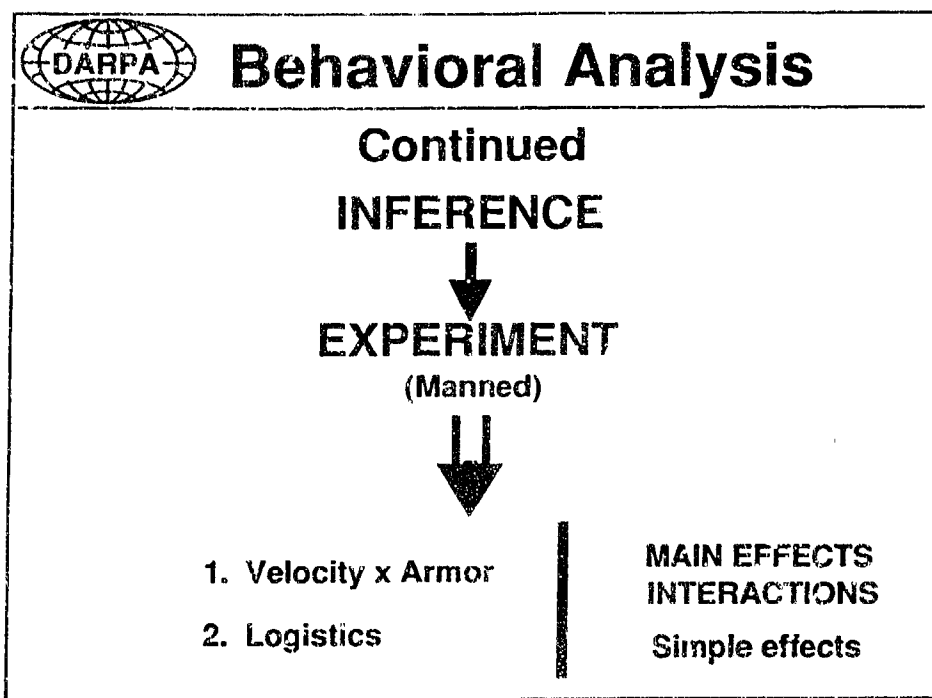
Next slide. I don't want to just examine what happened. I want to control so that I can make positive inferencing and so that I can know cause and effect; I want to conduct experiments; I want to bring a war forward to a point; I want to freeze it; and I want to understand and master what has happened. At that point, I want to introduce hypotheses, and I want to say, if I had twice as much armor or one-third more velocity, I would have tripled my advantage even more. And in fact, then I want to man up, suit up and I want to drive this experiment man on man. Perhaps I want to use a computer system to model out my new ideas. But, in particular, I want to go into a manned environment and try out my hypothesis and refight a war. That's why I'm controlling variables and I'm producing information that I could have a very firm understanding of cause and effect. I'm particularly interested in extrapolating my findings as main effects in statistical jargon. What are the main effects that I have manipulated and I've come to understand. And more importantly, what are the interactions? I've learned in analytical studies that the velocity was a key factor and that armor was a key factor in this hypothetical process. I now learn through experimentation that, in fact, they are very strongly interactive in their domination on the battlefield. Now, as a planner, as Paul Kozemchak may tell us later, I understand how to invest my R&D dollars because I know how the year 1995 or the year 2000 may look. I can also begin to understand simple effects. The key point in all of this is that I'm trying to produce insight. I do that, not only by producing a picture that I can master, but also an environment where I can produce new data that we wouldn't have had without that capability.

Behavioral Analysis

WHAT IS DIFFERENT

- RECONSTRUCTION TOOLS

- PRESENTATION MEDIA

- MANIPULABILITY OF DATA

Next slide. So what is different here? I think that there are three things in play that this simulation capability enables that are quite important. First, reconstruction tools, second is a presentation media. There are several ways of looking at, smelling, hearing, understanding what happened in a way that we've never been able to do before. And finally, and I think, most importantly, the manipulability of data to derive information.

DARPA Behavioral Analysis

PRESENTATION MEDIA

- **PLAN VIEW DISPLAY**

- **OUT-THE-WINDOW DISPLAY**

- **USER-DEFINED REPORTS**

Next slide. First the presentation media. We now can see a dynamic reenactment of war in two dimensions, make that three over time, with a plan view display. We can aggregate, we can zoom in, we can look at the company level of progress, we can get too cluttered and rise up and look at division interaction on a plan view display over time. We can select by class of warfare. I want to see all armor over the past ten days and I want to watch that progress in front of my eyes. I now begin to understand. Let's overlay artillery and infantry. I now begin to get that picture. So I have a very user friendly aperture into this world of combat that took place. Second, I have an out the window display. This, of course, is particularly important at a more tactical level. If I'm interested in those simple effects, with those interactions, I want to get inside that cockpit and understand. In other words, if I want to lead a team to a world series, I'd like to be able to talk and understand my cleanup hitter. I want to understand how the cleanup hitting process works. I want to get down on that very level of granularity and understand it thoroughly. And finally, there are user defined reports. Because of the process we use to reify this battle and confirm with the original soldier by asking, is this what happened, or is this what you think happened? We are able to understand, through that interaction, at his emotional and his gut and intellectual level what did transpire on the field.

Behavioral Analysis
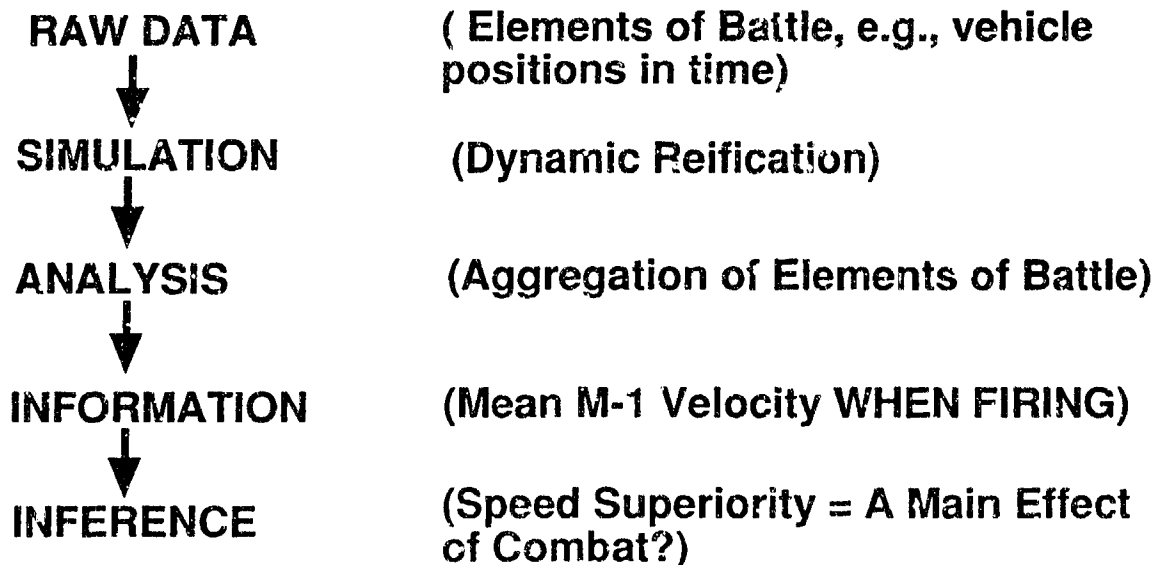
(DARPA)

RECONSTRUCTION TOOLS

- **DIGITAL TERRAIN DATABASE**
- **SEMI-AUTOMATED FORCES BEHAVIORAL SOFTWARE**
  - — vehicle dynamics confirmed or invalidated testimony as to movement rates, relative positions, etc.
  - — LOS and detection logic helped determine what vehicles engaged what targets and when
- **DATA PROBE: PRODUCED DETAILED LISTS OF FIRING EVENTS, LOCATIONS, ETC.**
- **INITIAL BATTLE RECREATION TO ELICIT DETAILED INFORMATION FROM PARTICIPANTS**
  - — brought them back to Iraq, when going there was physically impossible
  - — showed them their own units/vehicles in relation to everyone elses'
  - — allowed them to collectively see the battle in plan view and out-the-window, in real-time, slow-mo and fast forward modes, as many times as necessary

Next slide. The reconstruction tools themselves also provide a suite of capability that we've not had before. We now are compelled to produce a reproducible and refined digital terrain data base. We can now understand, very intimately, that geographical world the soldier fought on. The semi-automated forces software that interacts and drives are characters for purposes of interpolating between known points. Data probe is introduced here as a package. There are other means to do this, namely, one that the Air Force has produced for us, called Cause. This is a workstation that allows you to do a report after a simulation exercise. You're able to easily access the data and get a report on the average rpm of all M1 tanks when being fired upon, or any other measure or metric that you may happen to be interested in.

SLIDE 11

Behavioral Analysis

Utilizing Simulation to Support Inferencing

RAW DATA — (Elements of Battle, e.g., vehicle positions in time)

↓

SIMULATION — (Dynamic Reification)

↓

ANALYSIS — (Aggregation of Elements of Battle)

↓

INFORMATION — (Mean M-1 Velocity WHEN FIRING)

↓

INFERENCE — (Speed Superiority = A Main Effect of Combat?)

Next slide. Lastly, I contend in the last slide that the key is the manipulability of data or transformation of data to information. Because I have a simulation, I can aggregate things that didn't know needed to be aggregated. I can make them dynamic. I can begin to understand in a way that I never could have if I go simply from raw data to an inferencing process without the dynamic interplay of the ward cell. At this point I'd like to turn the podium over to Dr. Jesse Orlansky.

III-13

DR. JESSE ORLANSKY

INTRODUCTION

This paper considers potential applications of the powerful technology of distributed simulation that has been demonstrated in the re-creation of the battle of 73 Easting. 73 Easting is both a real battle and a significant application of a new technology. I will examine briefly what we know about 73 Easting, the types of data that are available about the battle, the types of analyses that can be performed with these data and, finally, some potential applications of these data and methods of analysis.

BACKGROUND

Seeing what happened in 73 Easting is a dramatic event for all observers. "That is just the way it happened.... it gives me goose flesh," is the common reaction of those, from enlisted man to four-star general, who were personally in that battle or who commanded it from higher levels. There is a good reason for this universal response. The re-creation of 73 Easting is based on a carefully reconstructed ground truth that all who were in that battle recognize and respond to strongly and positively.

The data base that drives 73 Easting contains, for each tank and armored vehicle in Eagle, Ghost and Iron Troops, precise information on each position they occupied on the battlefield and when, the direction and speed of movements, shot-by-shot firing events, type of ammunition used, and targets, hits, kills and misses throughout the entire engagement. We have similar, but much less complete, information about what the Iraqi vehicles did. We have actual voice recordings of some U.S. radio communications between these troops during the battle. All of this information was collected on the ground in Iraq where the battle took place, while U.S. troops still controlled the area and with the assistance of personnel of the 2nd Armored Cavalry Regiment who were in the battle. Data from other sources, such as the engineer battalion field survey of damaged vehicles, were used to supplement and confirm these reports.

The first animated version of 73 Easting was reviewed in July 1991 by Ghost, Eagle and Iron Troops in the SIMNET facility at Grafenwoehr, Germany and corrected as needed. The second version was reviewed at the Institute for Defense Analyses in February 1992 by members of the same troops and additional corrections were made. Although some incidents remain unresolved--primarily instances concerning which a U.S.

tank should be credited with killing a particular Iraqi tank--we have a valid and confirmed data base for the battle of 73 Easting. In fact, because of the precise data on the identity, location and time of events needed to drive the simulation technology, the quick effort to collect information on-site from the soldiers who were in the battle and the two reviews of the animated version for accuracy by these same troops probably makes our data on 73 Easting the most complete and most accurate for any battle that has ever been fought.

Available Data

Previous speakers have described the procedures used to collect data about the battle of 73 Easting, e.g., photographs of the battlefield, engineer survey of destroyed vehicles, interviews with personnel who were in the battle, audio recording of radio net communications and sketches, made on-site, of events before, during and after the battle.

This large and detailed data base contains both static and dynamic elements. The static elements include the terrain in digital form, features on the landscape (e.g., buildings, roads, telephone poles, sand berms, bunkers, U.S. and Iraqi vehicles, and munitions (e.g., TOW, 120 mm gun). Each of these elements include, in addition to their visual appearance, the functional performance characteristics of the vehicles and features that each represents, such as how fast tanks can move, the effectiveness of each munition against various targets at various ranges, and so on.

The dynamic elements include such details as individual firings, location of each firing vehicle and its target, time of firing, type of ammunition used, location and effect of a hit on target, vehicle movements, weather conditions and visibility (by naked eye and thermal sight). The data base for 73 Easting includes what each vehicle did, where it was and what happened on the entire battlefield, during a period of about five hours. When we observe any action of interest on the battlefield such as, for example, the Iraqi counter-attack against Ghost Troop in the north, Eagle and Iron Troops are being engaged, at the same time, on other portions of the battlefield even though we are not observing them. Using the "Flying Carpet" observation post, we can look at how Eagle and Iron performed on subsequent runs over the battlefield.

Types of Analyses

These raw data can be used to perform the following illustrative types of analyses:

* intervisibility between vehicles versus time to open fire
* effectiveness of first rounds

- number of rounds per target

- number of rounds per kill

- effect of hit on target versus type of ammunition and range

- rate of firing for each vehicle

- number of targets engaged per vehicle

- assignment of targets, according to vehicle

- hits and kills versus range

- firing opportunities, taken and not taken

- vulnerabilities, i.e., exposure to potential and actual enemy fire

- adherence to doctrine

- critical events that shaped the outcome

Potential Applications

In addition to the obvious value that an accurate record of an actual battle has for training military personnel in doctrine and tactics, the data contained in 73 Easting have potential applications in, at least, the following ways:

- review and validation of combat models

- compare company proficiency in battle versus prior amounts and types of training

- compare performance of personnel in the battle to prior performance

- in simulators and field exercises

- validation of readiness standards

- evaluation of doctrine and tactics

- effect of weather conditions, on both sides

- "what-if" analyses, e.g., examine the effect that different tactics, weapons, vehicles, sensors could have on the outcome of the battle.

The way in which the battle of 73 Easting started, developed and ended cannot be changed. Still, it is a matter of considerable interest to ask such questions as "What could have happened if, e.g.,"

- the weather had been clear

- the Iraqis had thermal sights

- Captain McMaster held his attack until he had reinforcements
- the Iraqis took advantage of the breach between Iron and Eagle Troops
- the Iraqis were more aggressive
- the Iraqis had M1 tanks instead of T72 tanks
- the Iraqis were prepared for, and not surprised by, the American troops.

The method used to re-create the battle of 73 Easting explicitly provides a way to introduce and examine new conditions of interest that could conceivably have changed the outcome of the battle. In this type of intervention, the battle of 73 Easting is permitted to run, without modification, up to some point of interest. Tank crews sit in tank simulators and observe the course of the battle but cannot change it. Then, at a selected point, a condition that was not present in the original battle is introduced, e.g., thermal sights become available to the Iraqis, or the Iraqis have M1 type tanks, or visibility is unlimited. At that point, friendly and enemy forces engage in a free play exercise.

This creates a new record and, quite probably, an outcome that can differ from what actually occurred in 73 Easting. This provides a means for judging empirically whether or not some different capability on either side or environmental condition (e.g., clear visibility) could influence the outcome of that battle. No single trial can be persuasive, so that well understood guidelines for collecting and interpreting experimental data must be respected. Repeated trials can be conducted using distributed simulation to provide a basis for deciding whether, for example, other tactics have merit or whether or not to build prototype equipment for more complete evaluation of promising components in field trials. The "what-if" capability inherent in 73 Easting provides a means to test a large variety of innovations related to doctrine, tactics and new weapon concepts based on the environment of an actual battle.

DR. JOHNSON FROM ARI

I've been on several panels with Jesse Orlansky before and I've never figured out whether it's better to be before or after him. I'm always sure that whatever position I am in, I should have been in the other one. Psychologists are a little bit like barbarians at meetings like this, because on a lot of the issues which concern engineers and technologists we take the solutions for granted. As you can see on the first chart, I look at 73 Easting, as both an event, it was an actual battle, and as a methodology. You can also look at it as an interactive, synthetic, multi-media environment--but the Army's been using such methodology for a number of years, at a place called the National Training Center. So what's new here?

73 EASTING: AN EVENT - A METHODOLOGY

INTERACTIVE, SYNTHETIC, MULTIMEDIA ENVIRONMENT WITH MULTI-LEVEL REPLAY - ELECTRONIC HISTORY BOOK

UNIQUE FEATURES

- **MULTIPLE POINTS OF ENTRY - "YOU ARE THERE"**

    - TIME

    - SPACE

    - ECHELON

- **MOTIVATION - SEIZES THE IMAGINATION & CAPTURES THE INTELLECT**

Certainly it's not that it's a synthetic environment, because the National Training Center is a synthetic environment, it's just in a little different media. In trying to isolate unique features, there are two aspects of 73 Easting that are worth highlighting. One is the notion of multiple points of entry into the battle both in time, in space and by echelon. A little later in the presentation I will provide some examples of our approach at ARI to data measurement, using an analysis based on the work at the U.S. Army's National Training Center. But I think one of the unique aspects in 73 Easting is the ability to replay the battle at multiple echelons. One of my favorite concepts of simulation goes back a number of years ago where it was said, a simulation is something that you can poke and safely see what wiggles. In 73 Easting, the participant can poke it and see what wiggles at different

echelons, and at different points of the battle, both in time and space. If you consider the issue of battlefield visualization, in terms of time and space relationships, as well as weapons capabilities, 73 Easting provides a unique tool to allow the soldier to understand the modern battlefield. The other unique aspect is motivation. In 73 Easting as we've seen from both this audience and the way they've reacted, and how other people have reacted, it seizes the imagination and captures the intellect. As a teaching tool, it provides a unique capability to keep the student interested, especially when the student may be a Colonel or a General in his mid 40's. We don't talk about training those people, we develop them. The point is, they're too old to be trained in the usual sense, you have to develop their own capabilities to perform. Motivation is a key aspect and by bringing in a real world event we get away from the base of sand we often have when we look at simulations with contrived scenarios.

Some of the starting points for data analysis or for measurement are shown on the next visual. These are issues which we have to grapple with and, implicitly or explicitly, come to a choice as part of getting on with a data analysis. First, consider the purpose of the analysis: is it a diagnosis, in the sense of identifying areas for improvement; or is it an assessment, a rating of how well an event occurred? These are very different kinds of measurement and analysis. A second point is the level of analysis. Whether we're looking at the task force or some larger unit, or going down to the micro level to look at individuals and how they performed. A unique aspect of 73 Easting is the wealth of data at the individual and crew level, which can then be related to unit performance. A third point is the type of measurement and the type of data: whether it's process in terms of the steps and the procedures one goes through; or whether it's in terms of the outcome, the products or the end state. One way of looking at this issue is that in the latter the focus is on what was accomplished, and in the former it's whether right things were done in getting there? There's not a one-to-one correlation, but you have a better chance of getting where you're going if you do the right things to get there. The last point is what I call a standard of comparison: whether you're considering the performance relative to some standard or criteria, and in 73 Easting you have a criterion; or whether the performance is compared to a standard, norm referenced. At the National Training Center we have both types of standards. We have standards established by the Army for how well certain tasks should be performed, but we can also compare units against other units. It's important to recognize that in 73 Easting the "n" is one. As we talk about comparison with the criterion, or comparison with the norm, we have to define what our terms mean.

STARTING POINTS FOR DATA ANALYSIS

- **OBJECTIVE:**

  DIAGNOSIS - IMPROVEMENT

  vs.

  ASSESSMENT - RATING

- **LEVEL OF ANALYSIS:**

  MACRO - TASK FORCE

  vs.

  MICRO - INDIV/SMALL UNIT

- **TYPE:**

  PROCESS - PROCEDURES/TASK STEPS

  vs.

  OUTCOME - PRODUCTS/END STATES

- **STANDARD OF COMPARISON:**

  CRITERION - BASED

  vs.

  NORM REFERENCED

To get at the process issues in a set of events, you need some logical sequence. Events don't occur in a random order. How critical are specific tasks? What are the standards? The conditions? The measurement? To illustrate these points, I'll use a brief example from our work at the Army's National Training Center.
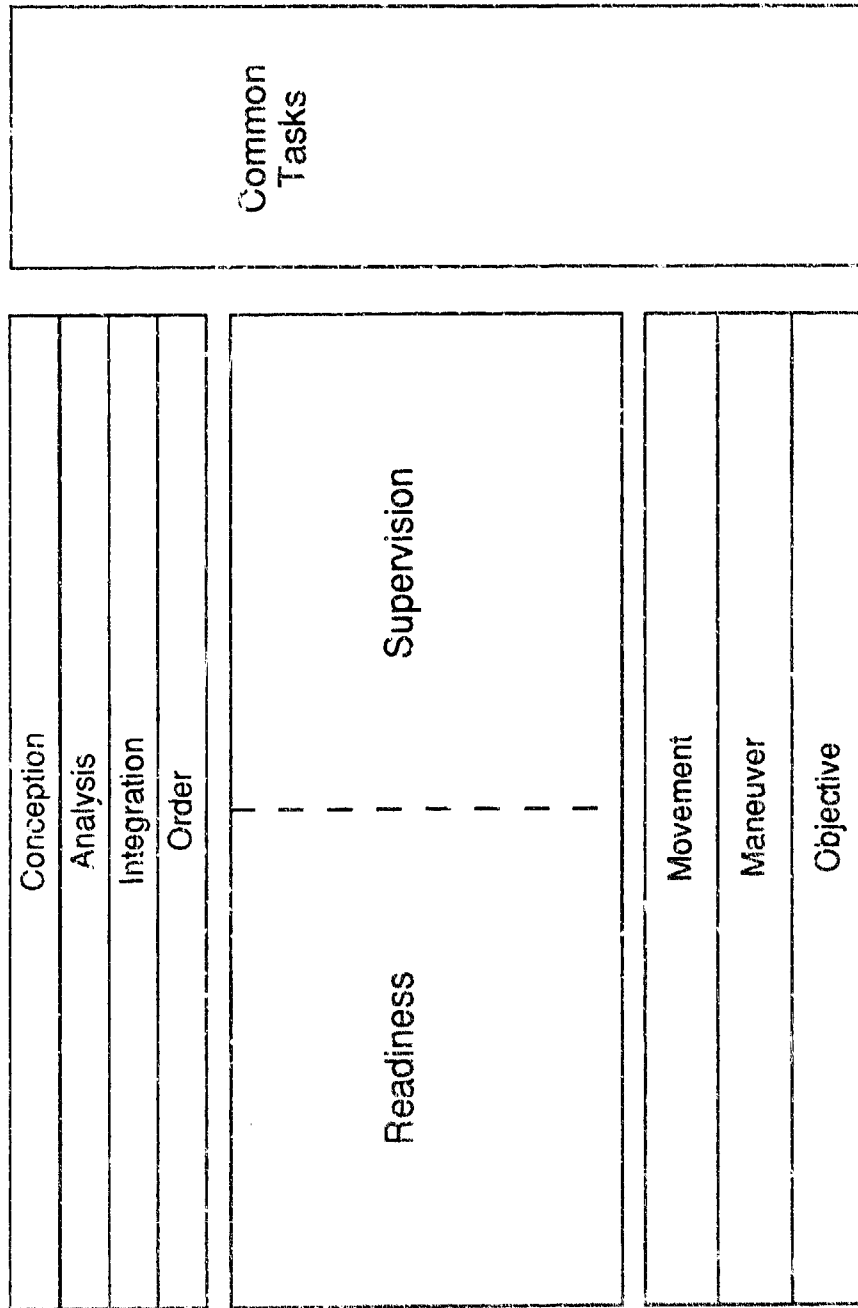
STARTING POINTS FOR PROCESS/TASK MEASUREMENT

- LOGICAL SEQUENCE OF TASK PERFORMANCE

- CRITICALITY OF TASK TO MISSION PERFORMANCE

- STANDARDS FOR TASK PERFORMANCE

- CONDITIONS OF TASK PERFORMANCE

- MEASUREMENT OF TASK PERFORMANCE

First, we use as a template for the data what has been called a battle flow diagram. There is a sequence to a battle: planning, preparation and execution. One can array the tasks or the things that have to be accomplished at each of these stages. There will be some which are unique to the particular mission and others which are common across an array of missions.

The next visual shows the sequence of tasks for a battalion task force in a deliberate attack. The exact tasks are less important for this discussion than the fact that we have arrayed the tasks required for the mission in terms of those which were done well, those which were done acceptably, and those which were not done well. Next, as you can see on the next visual, we have laid the tasks out in a flow diagram. We've separated the common tasks on the right hand side, shown the sequence of tasks in a logical order in each phase; we've coded those tasks which were done well and those tasks which were not done so well. What this diagram provides, if you go back to the purpose of measurement (whether it's diagnostic or assessment), is a basis for determining not just to what tasks units did well, but what tasks were the units performing, which led to the difference. Because we can compare units which did well, with units that didn't do well, we can compare not just in the abstract, but in terms which are meaningful to the participants.

My assigned task by LCDR McBride was to talk about personnel relationships in battle. To illustrate these relationships, I'll show some recent results that we've obtained from the National Training Center. These results relate platoon quality as measured by members' AFQT, an indicator of unit trainability, and leadership style to platoon performance. These results are especially interesting, if you think of the type of Army we have today, with a higher AFQT than ever before. With higher AFQT you get more trainable or brighter people. The results indicate that with bright people, non-directive leadership styles work best--you tell them what to do not how to do it. With not so bright people, you need not only to tell them what to do but how to do it. Moreover, if you reverse those leadership styles you get a decrease in performance. The performance at 73 Easting gives you an indication of the value to the Army of these quality soldiers. Another example of the personnel relationships that multi-level replay as in 73 Easting may allow us to get at is such vague concepts as commander's intent. A chief article of faith or doctrine, is that the commander's intent should be understood by the leadership and the troops down to the lowest level. Not just the commander's orders, but his intent--what the commander is trying to do. Through multi-level replay, the user of the kind of methodology used in 73 Easting may be able to operationalize what commander's intent really means in terms of specific soldier actions.

Battle Flow Framework

Conception
Analysis
Integration
Order

Supervision

Readiness

Movement
Maneuver
Objective

Common Tasks

EXECUTION PREPARATION PLANNING

TASKS FOR HIGH BDE--BN TASK FORCE DELIBERATE ATTACK--ARMOR BN

SUCCESSFUL

2	Coordinate Passage of Lines.
20	Maintain Security.
37	Integrate Engineer Effort into Command and Control System.
40	Update Administrative and Logistical Status.
45	Plan Communications.
76	Utilize Combat Service Support Assets.
85	Maintain Operations Security.
87	Designate Main Effort.
88	Plan Actions on Contact.
89	Plan Movement Security.
90	Plan Passage of Lines.
93	Plan Assault Phase.
94	Plan Supporting Attack.
100	Establish Air Defense Priorities.
101	Develop Air Defense Estimate.
103	Develop Air Defense Plan.
107	Operate Admin/Log Operations Center.
112	Operate Tactical Operations Center.
113	Issue Warning Order.
114	Conduct Mission Analysis.
115	Derive Commander's Intent.
116	Develop Tentative Plan.
117	Initiate Planning Process.
118	Coordinate Plans with Adjacent Units.
120	Organize for Combat.
122	Plan for Control of Supporting Units.
123	Issue OPORD.
127	Conduct Leader Rehearsals.
131	Disseminate Fire Support Plan.
132	Refine Air Defense Plan.
133	Position Air Defense Elements.
134	Rehearse Air Defense Plans.
139	Prepare for Emergency Resupply.
142	Conduct Briefbacks.
144	Organize Command Group.
145	Establish Contact with Adjacent Units.
146	Establish Communications.
147	Control Supporting Units.
148	Refine Plan.
149	Supervise Implementation of Plans & Orders.
152	Conduct Passage of Lines.
155	Support Main Effort.
156	Execute Assault Phase.
160	React to Enemy Air.
164	Conduct Emergency Resupply.
168	Maintain Contact with Adjacent Units.
170	Issue FRAGO.
174	Conduct Actions on Contact.
175	Control Supporting Ulnits.
177	Comply with Commander's Intent.
178	Report Combat Information.

BORDERLINE

17	Plan Maneuver Control Measures.
27	Establish Reporting Criteria.

|	
48	Conduct Reconnaissance and Surveillance.
62	Execute Combat Service Support Operations.
68	Conduct Reconnaissance and Surveillance Effort.
80	Conduct Leader's Reconnaissance.
81	Analyze Combat Information.
84	Disseminate Intelligence and Combat Information.
91	Plan Movement Formations and Techniques.
95	Plan Consolidation.
96	Establish Priority of Fires.
104	Conduct Mobility Analysis.
105	Develop Mobility Plan.
106	Prepare Engineer Estimate.
108	Determine Combat Service Support Requirements.
109	Plan Evacuation.
110	Plan Combat Service Support.
111	Plan for NBC Operations.
119	Graphically Illustrate Scheme of Maneuver.
121	Plan Fire Control Measures.
135	Control Air Defense Forces.
136	Rehearse Breaching Operations.
138	Rehearse Evacuation.
140	Confirm Task Force Operational Readiness Status.
141	Prepare for NBC Operations.
153	Move Units to Attack Positions.
154	Move Units to Assault Positions.
157	Prepare for Enemy Counterattack.
163	Report Obstacles.
165	Control Evacuation.
167	Maintain Communications.
169	Control Task Force Movement.

UNSUCCESSFUL

23	Conduct Terrain Analysis.
24	Conduct IPB Process.
26	Prepare Intelligence Estimate.
73	Execute Fire Support Plan.
79	Control Supporting Fires.
82	Develop Reconnaissance and Surveillance Plan.
83	Direct Intelligence Collection Effort.
86	Update Estimate of the Situation.
92	Plan Screening Fires.
97	Supervise Fire Support Planning.
98	Integrate Fire Support with Scheme of Maneuver.
99	Develop Fire Support Plan.
124	Verify IPB Product.
126	Conduct Battlefield Update.
128	Position Fire Support Forces.
129	Supervise Fire Support Preparation.
130	Rehearse Fire Support Plan.
143	Understand Control Measures.
150	Verify IPB Product.
158	Integrate Fire Support with Scheme of Maneuver.
159	Position Fire Support Forces.
161	Conduct Obstacle Passage Operations.
162	Mark Minefields.
166	Respond to NBC Operations.
172	Establish Task Force Early Warning System.

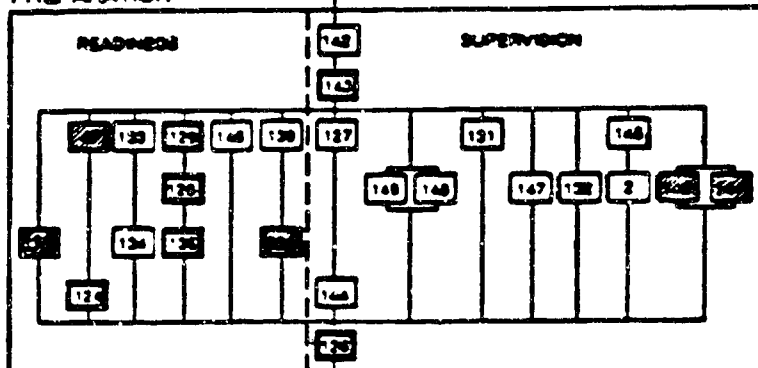HIGH BDE · BATTALION TASK FORCE DELIBERATE ATTACK · ARMOR BN
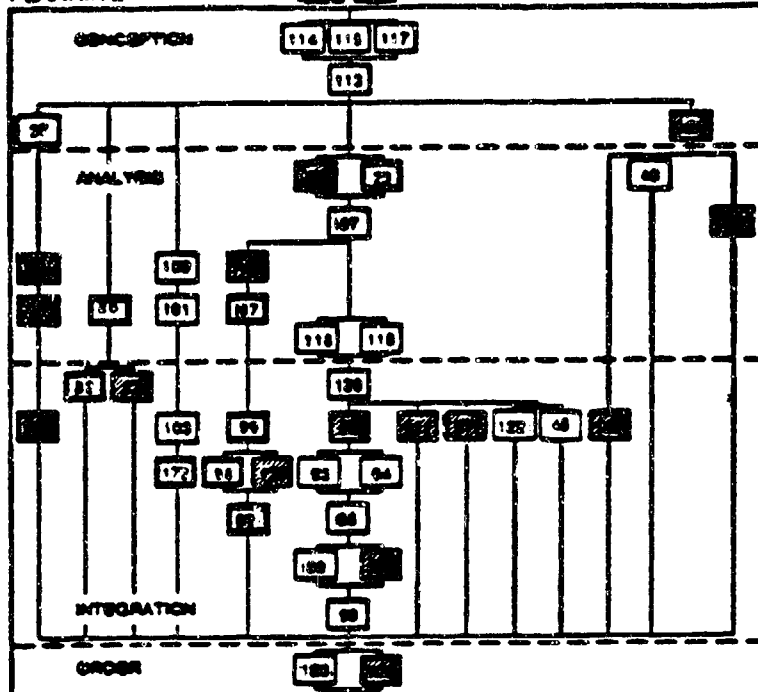
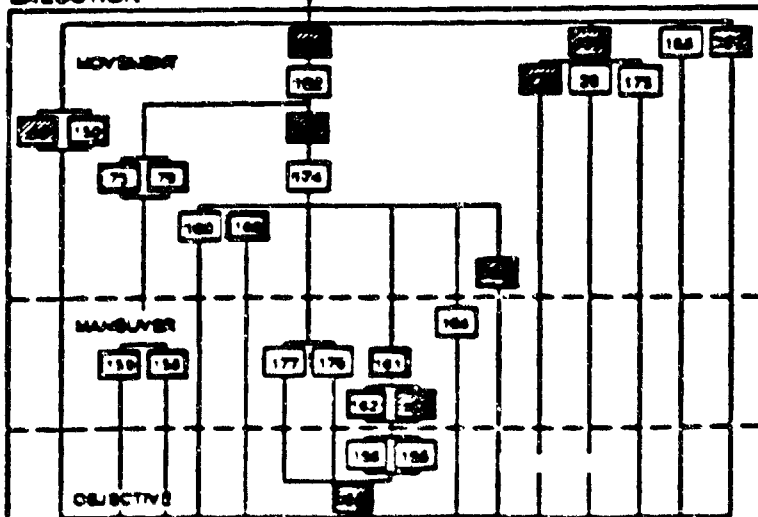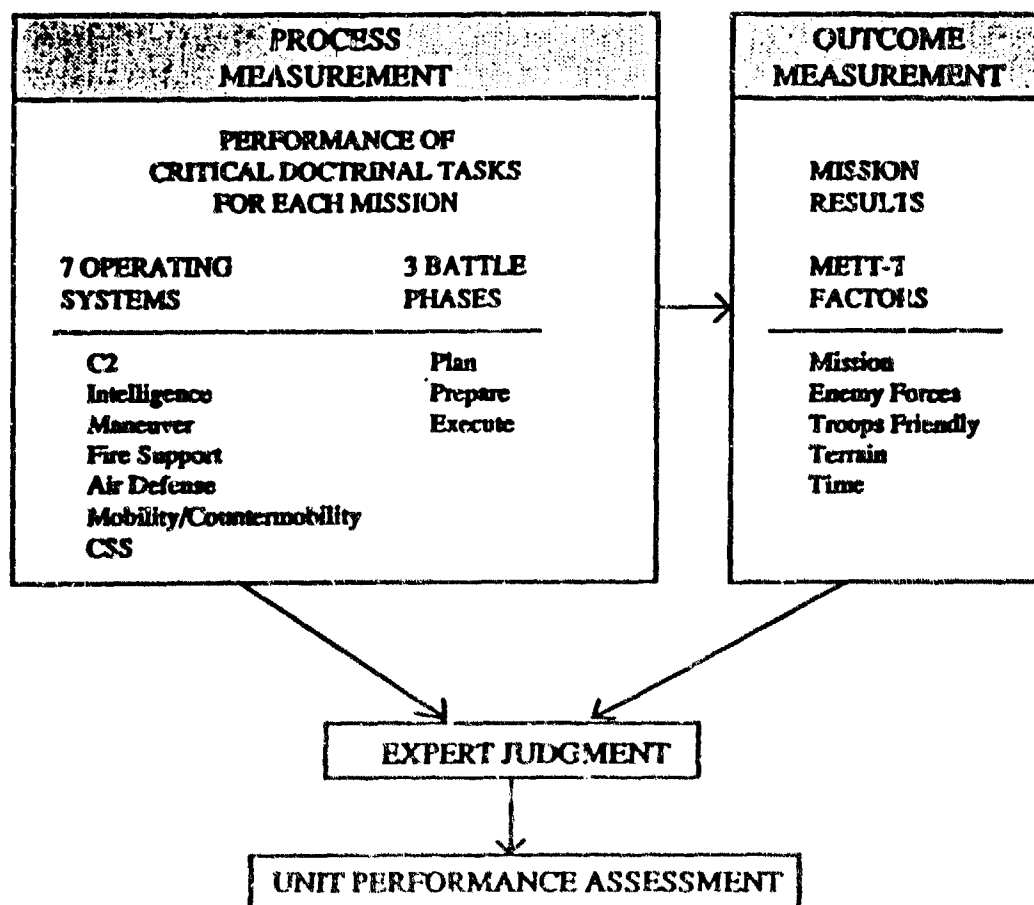# Relationship of Platoon AFQT with Platoon NTC Performance: Example

Relationship of AFQT with O/C Ratings of NTC Performance for Directive and Non-Directive Platoon Leaders
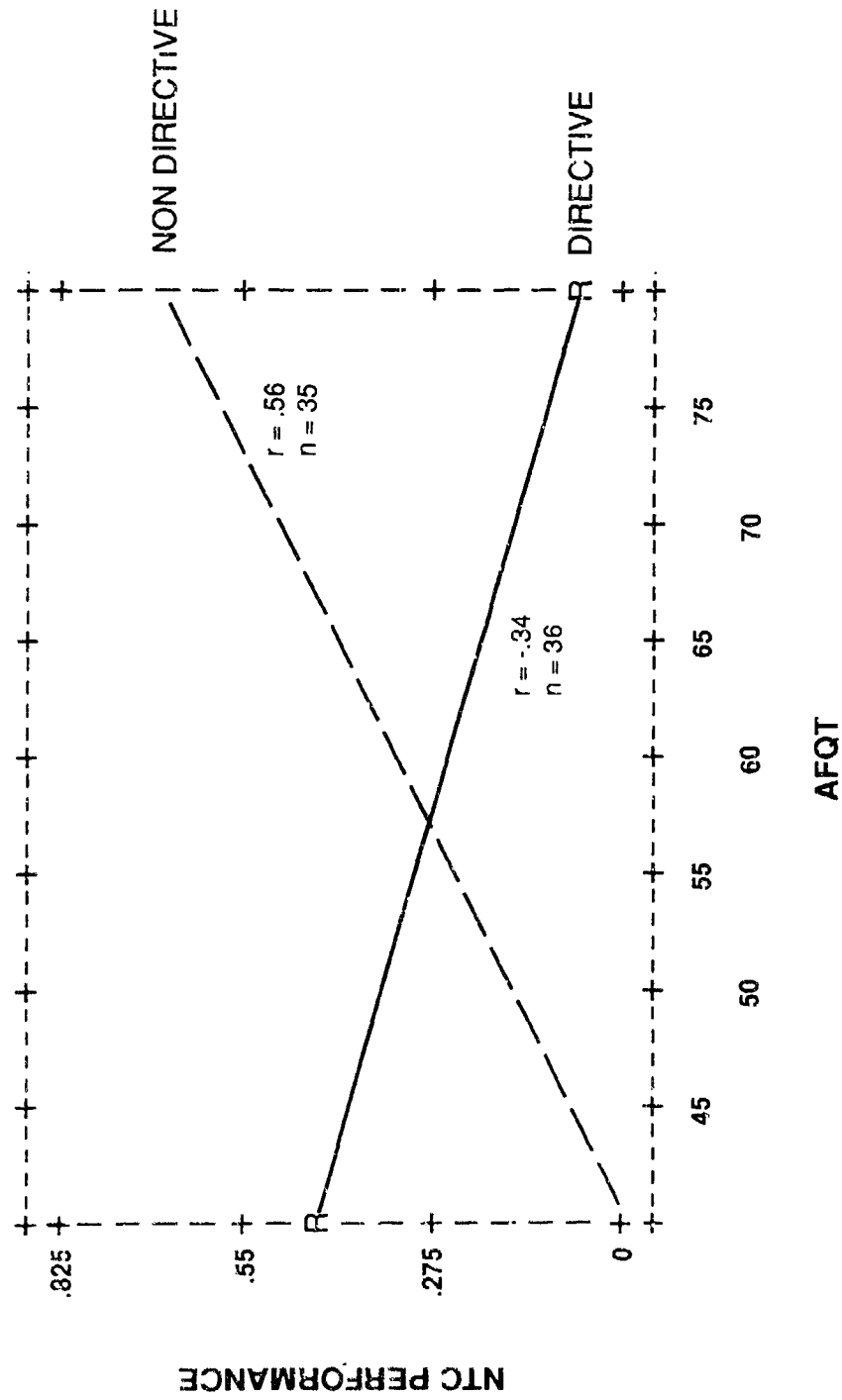
I'll summarize and put these thoughts together. I've talked about both process measurement and outcome measurement. Process measurement is much more directed at diagnosis than assessment. Outcome measurement is an assessment. We need both types of measurement tied together with expert judgment to be able to understand unit performance. 73 Easting provides a synthetic environment which is unique in that it allows the user to see the battle at many different levels of space, time and echelon. As a learning environment it exploits much of what we know about adult leaders--they're impatient, they want to get started on something, 73 Easting allows them to do that. It captures the imagination much more than similar methodology with a made up scenario. Adult learners want to make mistakes and learn from correcting mistakes. Playing "what if" options in a simulated battle provides an exceptional environment for military learning. Lastly, 73 Easting provides, in military value, a way to assess the product of learning, which is the user's skill and not the simulation itself. The increase in unit capability that comes from using this kind of methodology for training, development and the assessment of people. Thank you.

PROCESS MEASUREMENT		OUTCOME MEASUREMENT
PERFORMANCE OF CRITICAL DOCTRINAL TASKS FOR EACH MISSION		MISSION RESULTS
7 OPERATING SYSTEMS	**3 BATTLE PHASES**	METT-T FACTORS
C2	Plan	Mission
Intelligence	Prepare	Enemy Forces
Maneuver	Execute	Troops Friendly
Fire Support		Terrain
Air Defense		Time
Mobility/Countermobility		
CSS		

EXPERT JUDGMENT

UNIT PERFORMANCE ASSESSMENT

Key elements in Unit Performance Measurement System

DR. RICHARD BRONOWITZ, TEAM MIKE, CNA

My assignment from Dennis was a pretty broad one; tell me how any of this force level, real time simulator technology relates to the Navy. So, while it would be difficult to miss the mark totally, I suspect that I'm not going to say the kind of things that he had anticipated.

Let me tell you about the perspective that I bring. In the last five years, CNA has been asked by the Navy to look at many of the computer models they are using, and to conduct detailed evaluations to try to get a handle on the substance of what's underlying them. Over those years, we've reviewed about three dozen of these models. They range from small models (5,000 lines of code) to models of upwards of one million lines of code. It has been an across-the-spectrum kind of look. I must say that, quite honestly, we've never looked at anything near the complexity of SIMNET. The man in the loop representation here in SIMNET is very impressive, and should prove particularly useful for generating data on human performance and behavior. We've noticed that in the digital models, human behavior is not captured very well. Moreover, when I saw the idea presented earlier that this could be used as an historical reference, it's one of those brilliant ideas that after it's developed, you say, why wasn't that obvious? But one can easily imagine a future where libraries will be made up of these sort of reconstructions. So in spite of what I'm going to say for the rest of my talk, let me say I think this technology shows tremendous potential and it will be very, very important to us.

There is another side of the coin. I think that right now, the technology that's driving computers and graphics is outstripping our ability as analysts to use them effectively. The rest of my talk will be expanding on this issue. The comments should be viewed as directions for research, things to think about, and things to worry about. There are some very hard analytical problems to solve to make sure that this technology is used in the best interest of the Defense Department. Jack Thorpe, in a meeting of the DMSO, raised the issue of how this technology might be used across the spectrum of defense decisions. Up to now, much of the talk has been focused on historical re-creations and training. When he said that, I immediately thought about acquisition and R&D, because a lot of my experience is in that context. The fundamental problems we're going to face in using interactive systems are driven by the architecture in SIMNET, or in any of its possible descendants. That architecture is its very strength It provides the ability to

examine issues that we don't have anywhere else. But let me talk about some of the problems that we're going to have to overcome.

When we are looking at sophisticated systems like this, underlying the graphical representations are models; analytical models, mathematical models, computer models. When we use such systems to study acquisition and R&D issues, there will be models of detection, battle damage, weapons performance, and environmental effects included. Most of these phenomena are stochastic in nature; that is, there are probabilities associated with them, as for example, a weapon working or not working. So the question is, when we execute one run of a scenario, what can we learn legitimately? In some sense, what we have is one iteration of a Monte Carlo simulation. For those of us who've worked in the modeling business, we know that drawing inferences from one iteration of a Monte Carlo simulation is precarious. In a training world, I can see that it is possible over a period of time, six months, a year, 18 months, running multiple cases of similar scenarios, to develop a statistically sound data base. How would one do this in a study of acquisition and R&D issues? However, the problem is even deeper than that. Digging deeper into these models, no matter how detailed they are, there comes a point, where we as scientists don't understand the underlying phenomenology. There are parts of the physics or generation of required supporting data that we just don't understand well yet. As an example, consider the implications of low observable technology. In the past, there were many naturally occurring phenomena that were eliminated from the detection process simply by setting sensitivity thresholds high. But now that the targets are too small for those sensitivity thresholds, these phenomena may come into the picture. I don't think we understand those implications as well as we need to to be sure that what is produced by models represents reality sufficiently well to be useful.

We also don't understand probabilities of kill and probabilities of detection particularly well. Consider for a moment SAM PKs. In most of the models that I've looked at, although there are some rare exceptions, a single value for probability of kill is used to represent system performance, independent of where in the envelope the intercept occurs. It is generally accepted that SAMs don't perform as well on the edge of the envelope as they do in its heart. So, whether look up tables are to be used to bridge the gap between high fidelity system level models and models like SIMNET, or if hi-fidelity system level models are actually to be embedded in SIMNET, there's a big architectural issue to overcome. I'm going to talk a little bit more about system level models in just a second.

III-28

But first, consider another model that we've examined that attempted to combine man in the loop and real time execution with trying to run many cases to examine excursions. The trial solution of this team was to record operator actions throughout the process and then feed those actions into the model for subsequent trials as parameters were changed. Unfortunately, since the model was stochastic, events that occurred the first time didn't occur in other iterations, and units behaved unnaturally, like vectoring to intercept a bogie when there was nothing there. Missiles were shot when there were no targets, and none were launched when there were targets. So, there is a problem of how to go from a real time system to a system suitable for getting sufficient statistical data, so that we can be confident that the results are telling us what we think they are.

Now let's consider the notion of potentially misleading results. Again, one of the strengths of this system is that it feels real. People can really relate to what's going on in a simulated run. The large aerospace companies typically have flight simulators with domes, cockpits, and very realistic representations of air flight. Participants feel almost everything that's going on. Pilots have come out of runs saying that the simulation really felt like "my airplane." Uniformed aviators have the current context in which to think about flight operations. In the acquisition and R&D world, we intend to put them in situations that they have not yet experienced. An example of this occurs during tests to look at sophisticated EW played against tactical aircraft. The objective is to determine what information pilots would need and what sort of tactics they would have to come up with to be effective. When we looked at the details of how the electronic interactions were modeled, noise and barrage jamming were reasonable, but more sophisticated EW techniques just weren't modeled adequately. Yet everyone took lessons away because the experience felt real, and things that they learned were perceived to be important. Maybe what they learned was correct; I don't know. Certainly, it is possible to get correct answers from bad assumptions, but one can never be sure. So, there's a pervasive danger of getting misleading results.

One of the major tasks that we've had at CNA over the years has been to reconstruct Navy activities, both real operations and exercises. In these reconstructions, we've seen that the so-called "fog of war" drives much of what happens. False information and other contributors to that fog are not modeled very well in any of these simulations. There must be considerable effort expended to better represent misleading and false information into this kind of simulation process. I know the argument that when you exercise these simulators, operators generate enough false information on their own. But

sensors also generate information to which people react. We must determine the extent to which that information generation should be included.

As we try to infer lessons from these simulators, we must also decide whether generic system models are sufficient or must we include systems specific models? In the analytical world, we are turning more and more to computers and software to help us learn lessons. In developing actual weapons and system, we're also turning more and more to computers and software. The Aegis radar, for example, is a phased array radar driven by software. The energy management that directs the radar beams is controlled by software; for example, the radar reacts dynamically and directs more power where there is jamming. Another example is in a weapon's scheduler. The Aegis system was built so that the ship itself will schedule SAMs through a whole attack of incoming missiles. The software determines which missiles will be engaged and in what order, with complex but reproducible logic. When we've looked at generic algorithms that have tried to model this performance, there have been cases they haven't come sufficiently close to what the ship will do. A question to be addressed as we examine system performance, is "will generic models suffice or must systems specific models be included?" It's a very difficult question.

In terms of behavioral representations also, particularly relative to semi-automated forces, there needs to be a lot of work. Yesterday someone mentioned the notion of combined arms. If, in the real world, we use HARM against radar sites, and still operative sites cease radiating, what behavioral representations should we include to generate this reaction? Will a single HARM suffice, or must there be a large salvo or a sequence? And yet, how the opponent behaves or reacts to the things that we do is very likely to drive the bottom line results. In the Navy, at least, when a new system gets developed, it takes a number of years after reaching the fleet for tactics that really make sense for the system to be developed. While a system like SIMNET could be a help in developing such tactics, when examining tactics before the system is developed, are we sure that we're doing the system justice? To what extent are excursions required?

I already mentioned some problems we have in doing sufficient excursions. So how do we represent the employment of a new system, particularly a revolutionary one, as opposed to an evolutionary one? Will the semi-automated forces on the other side use the same tactics they used against our current systems, or will they exhibit a dynamic reaction?

When dealing with men in the loop, there are questions of experimental design. In running multiple cases, should the same people be used in all cases; if so, what is the impact of the learning curve? How can it be factored out? If different people are used, some learning is required? I'm sure that these are all soluble problems, but they are not to be taken lightly. We also have to account for the performance being reflective of specific individuals. Consider the case that Jesse talked about, just before, of McMasters turning to attack the tanks south of him. If someone in a simulation decided not to do that, and our tanks were picked off, we would learn one thing. If the participants acted as McMasters, we would lea.. something else. There are decision nodes that are pivotal in the course of any engagement, and we have to examine enough of the likely paths and weigh the likelihood that each would occur to be able to draw true inferences. In summary, here are the kinds of things I believe are necessary if we are to really harness the tremendous powers of this technology.

One, I think that we need to think through the relationships between this kind of technology and the digital models currently used to support the acqu' tion and R&D process. Are there ways to efficiently interchange data from one level of model to another? I know SIMNET was always designed to have people involved. However, is it possible to work on the behavioral representations so there could be a two-sided, fully aut nated system? This is consistent with the notion that Paul Davis of RAND is pushing in his paper on variable resolution modeling. The idea is that for any model, the user can pick the level of resolution necessary for each particular application. Furthermore, the various models will be consistent when assumptions are equivalent. Work must be done to decide whether that's feasible. Finally, I asked the question yesterday, and I asked it because I expected to get the answer that I got. I asked whether decision makers feel that they have enough dialogue with the model developers so that they u. lerstand the limitations of the models. And it may be that the Navy is different from the other Serv es, but my experience is that there is not sufficient dialogue. Models are used beyond where they were intended to be used, beyond where they're applicable. The decision makers don't know the bounds that limit the envelope of applicability. If we define those bounds and work with the decision makers, the defense decision making apparatus can get tremendous leverage from this technology. If we don't, I'm afraid we are going to wind up with a lot of misleading information and perhaps some wrong decisions. That's my story. Thank you.

DR. RANDY STEEB FROM RAND

As you can tell from the handwritten sign in front of me, I'm a stand-in for the person who was just mentioned, Dr. Paul Davis. I would like to warn you that while Paul is quite an individual, we have very different viewpoints on modelling and simulation. Whereas he tends to be a high echelon, high level researcher--essentially a planner and analyst who's most comfortable at the corps and theater level--I tend to be a high resolution modeller, and I'm most comfortable at the individual system and subsystem level. You can kind of see the difference between those two sides in that Paul gives talks at various capitals around the world, while I end up in Wiregrass, Alabama coaxing AIRNET to try to look like an OH-58D, and spending a lot of time next to a VAX in Santa Monica working with JANUS. The work we're doing at Fort Rucker, Alabama, is important in that we're going beyond the normal SIMNET mode. We're going beyond training, looking at the system as an evaluation and acquisition decision-making tool. We're looking at very specific characteristics of the system: sensor systems, aerodynamics, vehicle handling qualities, etc. In this process we have arrived at a lot of interim conclusions about what kind of data analysis and special processing we need. Before going into this, I wanted to mention that General Thurman yesterday suggested that he wasn't sure whether or not SIMNET is going to be used in the LH program. We are going to be looking at the LH in our Rucker work. LH (also called RAH-66 or Comanche) in the third quarter of '93 is scheduled for a developmental test and evaluation cycle with SIMNET. So it is in the schedule. Also, there was some discussion of using JANUS to recreate scenarios. A lot of you are familiar with JANUS. it's a two-sided wargame, it doesn't have the 3-D characteristics of SIMNET, but it's a high resolution, individual system wargame. We look at a lot of direct and indirect fire systems such as UAVs, advanced light tanks, kinetic energy weapons, smart munitions, smart mines, all that sort of stuff. As you get to more and more complex systems you add more and more to the model. You essentially keep on tacking on things. We've added everything from weapons effects models, missile flyout models, geographic information systems, reduced signature effects, and helo and fixed wing maneuverability models. We're now importing JANUS to a Sun UNIX environment so that we can integrate it with other models. So one of the issues that we have been examining is whether or not SIMNET can be linked with other models, in line with what Dr. Bronowitz mentioned. One of the things that happens is that as you add on more and more of these augmentations, it gets to the point where you have too many wheels, too many gears, too many things added to your system and you need to basically get on with it.

This was a point made yesterday. We found that you can use SIMNET to make preliminary evaluations and examinations of certain systems, but it appears as though we need to add certain key capabilities, at least until we have a network standard, an ability to link a number of different distributed advanced simulation systems that all work smoothly together.

The two issues that I wanted to talk about today are: first, what is the right model or the right combination of models, and second, with the assumption that other panel members will be talking about post processing and data analysis, I wanted to take the other side of the coin, preprocessing. What kind of a preprocessor should you have to set up an effective experimental design, to calibrate the various subsystems, and to flexibly examine a range of develpmental options. Effective preprocessing in turn makes postprocessing and data analysis that much simpler.

Let's look at the first question--is SIMNET the right model? Is it the right model for reconstruction of engagements, training of crews, and evaluation of systems? I'm not the stuff made of martyrs, so I'm not going to stand up here and say no, SIMNET's not the right one; you should all use JANUS. In fact, I don't believe that. Some people have suggested JANUS for use in reconstructing scenarios and events that have actually occurred, and they've made some attempts at that. It has not worked well, partially because it does not have the face validity of SIMNET. You don't have a stealth capability to fly through the simulation and determine what sorts of events really occurred, and you don't have reactive rule-based behaviors, such as those expressed in the command instruction sets in SIMNET's semi-automated forces. Nevertheless, JANUS has certain characteristics that might be useful for integrating with SIMNET. It has some detection algorithms that are fairly effective, more sophisticated than some in the semi-automated forces. We and others have looked at ways of upgrading these detection algorithms, extending their use to reduced signature situations with camouflage, clutter, and weather effects. These algorithms might be embedded in SIMNET or they might be called as subroutines. JANUS or other high resolution simulations may also be useful for increasing the number of objects you're working with. We often run JANUS with 1200 objects on a side, with fast processing using accelerator boards. But SIMNET augmented with JANUS is still not sufficient for many system evaluation tasks. High performance, special purpose simulators seem to be needed. There are a lot of expensive flight simulators out there using GE Compuscene, Sogitech, Megatech, and Evans and Sutherland CIGs, that themselves have ground battle simulators. Unfortunately, these

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ground battle war games are typically very limited, and the system itself is typically expensive and cumbersome. SIMNET is a much more appropriate platform and architecture, but once again here, there are certain advantages to linking outside systems. For example, the NASA-Ames CSRDF simulator has a rotary wing maneuver model with over 120 degrees of freedom. Doc Dougherty spoke yesterday about electronic warfare and how you can use something like electrons in space, a model of electronic warfare that would handle both the sky ground situations, as well as clutter backscatter, diffraction and multi-path. Assume you have a suite of models that are hooked up with SIMNET, either as separate modules or as distributed programs associated with different sensor and weapon systems. Either way, the models produce messages as traffic on the SIMNET network, which can be received, reacted to, logged and analyzed. Some synchronization problems may have to be overcome, especially if separate dedicated processors are assigned to such functions as command and control modeling and radar functions.

The second topic, preprocessing, is one that I think ties in more with the panel discussions. I've been looking at ODIN on the screens here, and the system seems to have greater preprocessing capabilities than that of the Rucker AIRNET system. It appears to be easier to input a laydown, define the characteristics of the systems, and orchestrate a scenario than at Rucker. Even so, you'd like to have even more extensive capabilities, such as being able to define relationships between systems. I'll get into that in a second. First I'd like to note that one of the main problems we have with a new system is calibration. SIMNET entities include manned crew stations, semi-automated force units and management command and control components. The movement, detection, and weapon performance of these representations must be consistent among themselves and with the actual systems. If JANUS, CSRDF or other systems are linked up, these have to be calibrated also. Flexible preprocessing is essential to this calibration process, as it allows the user to set up standardized scenarios. The user can get some confidence that the system components act as expected under a wide range of scenario conditions--targets in cover, moving, firing, at different ranges, in weather, coordinating among themselves, etc.

A second function important for preprocessing is the setting up of relationships-- linkages between interacting objects. Some relationships are present now in SIMNET, such as command structures, communication links, and formation geometries. In the example of 73 Easting, there is also the linkage of who shot whom. As the system now stands, you can use this linkage to simply recreate the kills deterministically, or you can freeplay the battle with the SAF and see who kills whom. It should be more educational to

freeplay with the SAF but use relationships to narrow down the possible behaviors. For example, the engagement data sometimes tell the position, area of responsibility, and fire control of each unit. You may also know the timing and direction of shots. This could be used to pair one firer with several different targets, and essentially constrain the scenario outcomes. By making these connections, you can limit the number of possibilities and come up with what would be a more anchored, or more plausible result of the scenario. The preprocessor inputs the links between systems, and allows the analyst to interrogate system interactions. For example, the analyst could mouse on several different systems and determine which ones are in LOS, which are ready to fire, or which are part of an engagement grouping.

My last comment is that when we were making runs in Fort Rucker, we were often not able to observe exactly what was happening from the pilot's viewpoint. We would have to run between the cockpit, battle master station, and SAF stealth station to put together a view of the situation. It would be nice to have a configuration where the observer could have stealth, plan view, and repeater displays in the cockpit itself. This configuration might compromise the crew experience during actual test runs, but would be extremely helpful during scenario and experiment development.

These are all recommendations, more from the user standpoint than from the top level system architect. I see these as essentially additions to the toolbox; refinements to the system. I'm fully in support of SIMNET as a tool and I think it's the only way that a lot of these examinations can be made. Thank you.

McBRIDE: We are going to take a 20 minute break. I tried to begin the session with a provocation. I want to begin the break with a provocation. Dr. Bronowitz, if I understood you correctly, the battle of 73 Easting was but one run of a Monte Carlo simulation and there may be a fidelity problem because it doesn't match the models...

Our next speaker is Dr. Jim Metzger from DAMO.

DR. JIM METZGER FROM ARMY ODCSOPS

When I came to this conference I knew a very limited amount about SIMNET technology. I've learned a great deal at this conference, at least a great deal in my own estimation. On the other hand, giving you a full brain dump of what I know will take maybe two or three minutes.

My background in modeling is at the U.S. Army Materiel Systems Analysis Activity (AMSAA) at Aberdeen Proving Ground, MD, and at the U.S. Army Concepts Analysis Agency (CAA) in Bethesda, MD. In those agencies I was involved in developing and using computerized combat models, although they were always fully automated rather than interactive models. I have limited experience with interactive simulations and no experience with SIMNET-type technology. Currently I work on the Headquarters, Department of the Army (HQDA) staff in the Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS). My office monitors studies and analysis at the theater and force level performed by CAA, RAND Arroyo Center, and contractors; at the corps, division, and small unit level performed by the U.S. Army Training and Doctrine Command (TRADOC) and contractors; and to a limited extent at the system level performed by the Ballistics Research Laboratory and AMSAA.

I would like to share my thoughts on applications of the technology and methodology presented at this conference. These are my thoughts alone. I certainly cannot speak for the Army.

There are three areas that I want to discuss: first of all, applications of the technology; secondly, applications of the kind of data collected from 73 Easting; and thirdly, what uses might be made of the linking of historical data and SIMNET-type technology. I will emphasize applications to analysis and training.

First of all, regarding applications of technology, the most obvious one is training. A problem here is that the simulation workstations are expensive, when the total number that must be procured to train Army forces is considered. One possible source of funds could be reduced field training. However, measuring the value of simulation-based training viz-a-viz field training is difficult. Consequently, there is an understandable reluctance to reduce field training. Other applications are in system development, and analyses supporting materiel acquisition such as cost and operational effectiveness analyses. Other applications were mentioned yesterday; namely, force mix, force design, and doctrine development. Another that is worthy of emphasis is testing; in particular,

operational testing--where SIMNET-type technology can be used beforehand in designing the test, and afterwards in interpolating and extrapolating to other conditions that were not or could not be tested. Still another potential application is education. Clearly the kind of education we're talking about here is at the small unit level. Returning to analysis, the kind of technology involved in SIMNET makes most sense at the small unit level; that is, the kinds of analysis that support doctrine development, force design, force mix, and materiel acquisition, and are performed by TRADOC; and the kinds of analysis that support R&D and acquisition, and are performed by the Army Materiel Command, Program Executive Officers, and Project Managers. Here the system of interest can be examined within the context of a combined arms battle. The Army has a number of programs related to this SIMNET technology. One is the Combined Arms Tactical Trainer, an umbrella program that includes the Close Combat Tactical Trainer (CCTT) and programs dealing with aviation and air defense. CCTT is getting started formally now. Another program is the Battlefield Distributed Simulation-Developmental (BDS-D), a derivative of SIMNET for system development applications. Currently the Army is planning a Distributed Interactive Simulation capability to integrate these programs and thereby take advantage of multiple users of the same technology.

In the area of the applications of the types of data collected from 73 Easting, historical data can be used to validate models and input data; that is, to improve the credibility of models used for analysis and simulations used for training. Also, historical data can be used to measure the value of training and training simulations. Given knowledge of how units were trained beforehand (whether via field training or simulation-based training), the historical data can yield indications of how that training translated into operational capability.

The third area of potential applications is the one that I have the most difficulty with--how to take advantage of the linking of historical data and the SIMNET-type technology. As mentioned earlier, "what if" drills provide one possibility. For instance, system modernization can be evaluated, or alternative tactics and doctrine can be assessed. To evaluate system modernization, the simulation can be executed with historical data as the baseline and then with modernized systems as an alternative case. To assess alternative tactics and doctrine, the simulation can be executed with historical data to a point in time, and then different tactics and doctrine can be introduced. Surely there are other applications of the linking of historical data and SIMNET-type technology.

Our last speaker is Paul Kozemchak, from the front office at DARPA and OSD.

PAUL KOZEMCHAK, DARPA

Dennis has asked me to talk about R&D budgets, and other money issues. This is the first opportunity I've had, however, to publicly thank Jack Thorpe, Dennis McBride, Doc Dougherty and other colleagues at DARPA; Jesse Orlansky, Neale Cosby, General Gorman, General Brown, Gary Bloedorn, and others at IDA. About a year or so ago I essentially knew nothing about SIMNET and now I understand a little bit more about the "virtual world" thanks to their assistance. Having said that let me also absolve them of everything I'm about to say.

VIRTUAL WAR
WITH
VIRTUAL WEAPONS
FOR VIRTUALLY NO MONEY

This was the title that I thought I would originally have on my remarks, but after listening to the session yesterday, I thought I might change it to the following:

VIRTUAL WAR
WITH
VIRTUAL WEAPONS
FOR VIRTUALLY NO MONEY

-- THE FUTURE OF MILITARY
SIMULATION?

NAME THIS CRISIS

- Do They Have Nuclear Weapons? Where Are They? What Will They Target? How Much Warning Do They Have?

- Where Are Their Missiles? Are They Ready To Fire?

- Must We Invade To Find Them?

- Must We Overthrow The Government To Be Confident We Found All Of Them?

- Iraq 1991?

Next slide. I also want to add a cautionary note to the Army officers, and Marine officers in the audience. My views here are not based on anything having to do with 73 Easting. Let me tell you a bit why. I'm in a situation where every now and then I am asked t come and give a no- notice, no-charts briefing to senior OSD officials on topics of their choosing. About this time last year, shortly after Saddam had invaded Kuwait, I got one of these calls and I was made, during the course of the meeting, access to sensitive back channel traffic, it was apparent that we had a lot to do to get ready. So I was asked, what could DARPA do to help the situation. Well, thanks to the colleagues that I have already mentioned to you, I had been thoroughly tutored in what then was to become the living map and project ODIN. And as I was leaving the senior official's office, he asked, what's this METT T? I said well, I wasn't sure, but in good TQM fashion I said I'm pretty sure that's the customer we're going to be working for--Middle East Trading Task Force Temporary. So I'm not going to say anything about land warfare today.

Before I get to the budgetary issues, I do want to give you some sense of my history in reconstructing other crisis and other cases. And as I've indicated here, if you've looked at these issues--Does the enemy have nuclear weapons? Where are they? How

much warning are we likely to get? Where are their missiles? Can we find them? Must we invade and overthrow their government? If you've thought the answer was Iraq 1991, you were wrong. Or, let me put it this way, you were only half right. As a matter of fact, the answer was Cuba in 1962 and I must say I profited from many hours of discussion with then, General Maxwell Taylor. In going over some of the same sorts of issues, kinds of questions, that subsequently come up in the deliberations that we went through in Desert Storm, were not unlike the deliberations that the Excom went through back in 1962.

(DARPA) Reconstruction of Past Cases

- 1956 Suez/Hungary
    -- Largest "Mass Gas" in SAC History

- 1962 Cuban Missile Crisis
    -- Estimates of Consequences of Execution Wrong
    -- What "13 Days"?
    -- How Many Nuclear Weapons Used?

- 1973 U.S. - Soviet Naval Confrontation
    -- Melee Warfare vs. Lone Wolf

- Classified National Exercises
    -- Who Wants What Information When?

Next chart. I've been personally involved in attempts to reconstruct, particularly from the point of view of intelligence and nuclear operations, many past crises. Any one of these, as you might imagine, can take a considerable amount of time to go through, but I want to emphasize that there is nothing about what you have heard, in the last couple of days, about the utility of simulation that is peculiar to 73 Easting. Let me take one, that's here that I was involved in. That was the last U.S./Soviet Naval confrontation in the Eastern Med in November of 1973 after the Yom Kippur war. Let me add, CNA has done an outstanding and I think unclassified reconstruction of some of the data there and I would commend it to you. But there was a situation in which it was something I believe was unique in the annals of at least U.S. submarine warfare. Lots of submarines involved, lots

of carrier battlegroups involved, lots of aircraft up, very short expected timelines for the engagements, on the order of 15 minutes or less and no prior practice of that situation and no exercises that trained the commander. It was the very first time that the carrier battlegroup task force commander actually had SSN's chopped to him. No real good way prior to 1973 to practice that problem. I've also been involved in several other highly classified exercises, where the problem has been to sort out the demand for information of senior decision makers.

(DARPA) Reconstruction of Past Cases (Cont'd)

- 1991 Scud Hunt

  -- Future Concurrent Regional Contingencies
     Theater Priorities

     -- All Past Cases Involved Complex Operations
        Never Practices Before or Since.

     -- All Have Major Implications for R&D

Next chart. I expect to be involved in more attempts to reconstruct, for example, the problems in hunting scuds. But there's one thing that I've noticed that's been common to all of these attempts to reconstruct these crises, they have all involved very complex operations, large numbers of people, large numbers of weapon systems, doing things that they had only been partially trained to do. And probably could never have practiced in peacetime even if you had had the foresight to be able to say that this was going to happen. And they all have major implications for research and development.

How Are Defense RDTE Budget $ Determined?

- Arbitrary Budget "Rules of Thumb"
  - -- Fixed Share of Top Line
  - -- "Fair Division" Slice of Pie
- "Match" Weapon System Projected IOC
- "Match" Projected Capital Inventory Age/Rollover Rate

Result:

- Chronic Underinvestment In Military Science and Technology, High-Risk, High-Payoff Programs (New/New Problem)

- RDTE "Linked" To Procurement - No "Options" Process

- Implicit Belief In Free Lunch - $ Down, Technical Progress Up

- Qualitative Superiority In Future?

Next chart. When asked to address the issue of how R&D budgets have been determined in the past. (Could we have the budget charts at the same time?) What I've plotted here is the share of the Defense RDT&E budget as a function of time in the period Fiscal Year 1962 to 1989. Now what you see is that the RDT&E share has averaged roughly about 10 percent of the budget. And I say, was that just an artifact of the data or is there a model behind it. Well, low and behold, if you do some digging, what you'll quickly discover is that there really is a model behind it. For some years, OMB had an unwritten rule. That the defense RDT&E account should be roughly 10 percent of the budget. OK? So that's what we're working against. There are other attempts over the years to refine these estimates for the budget in process, fix the shares, try and decide the rough division of the budgets among the respective services, attempt to take individual weapon IOCs, back out from the production schedule, what the RDT&E lines therefore should look like over the extended period of time, attempt to match the rollover rates and average inventory ages of aircraft or other vehicles to a production schedule and then slave that in turn to an RDT&E account. Well, what's the result?

THE 10% RULE

DOD $RDTE = 10% DOD TOA
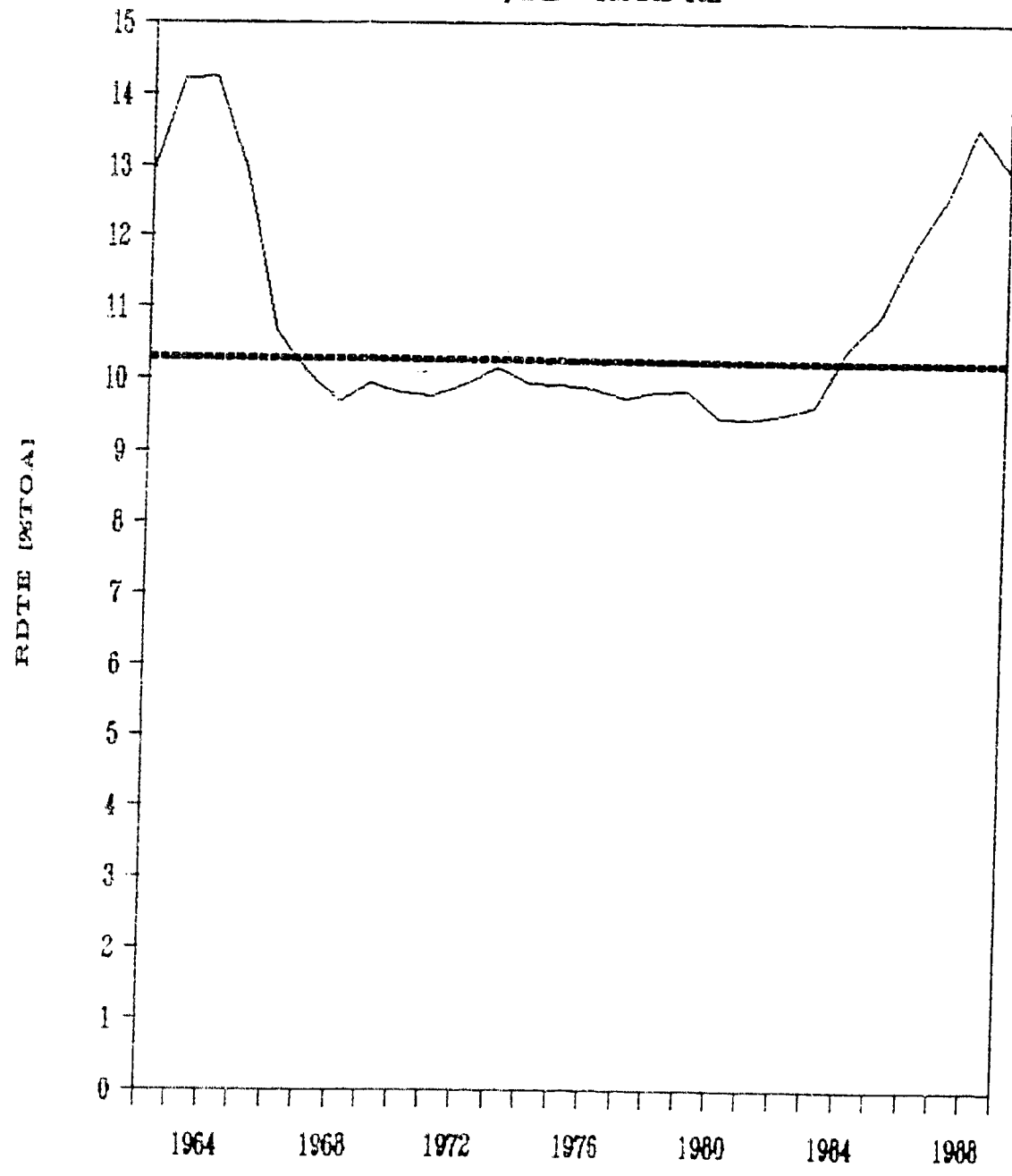
BUSH'S LAW AND DOD'S TECH BASE
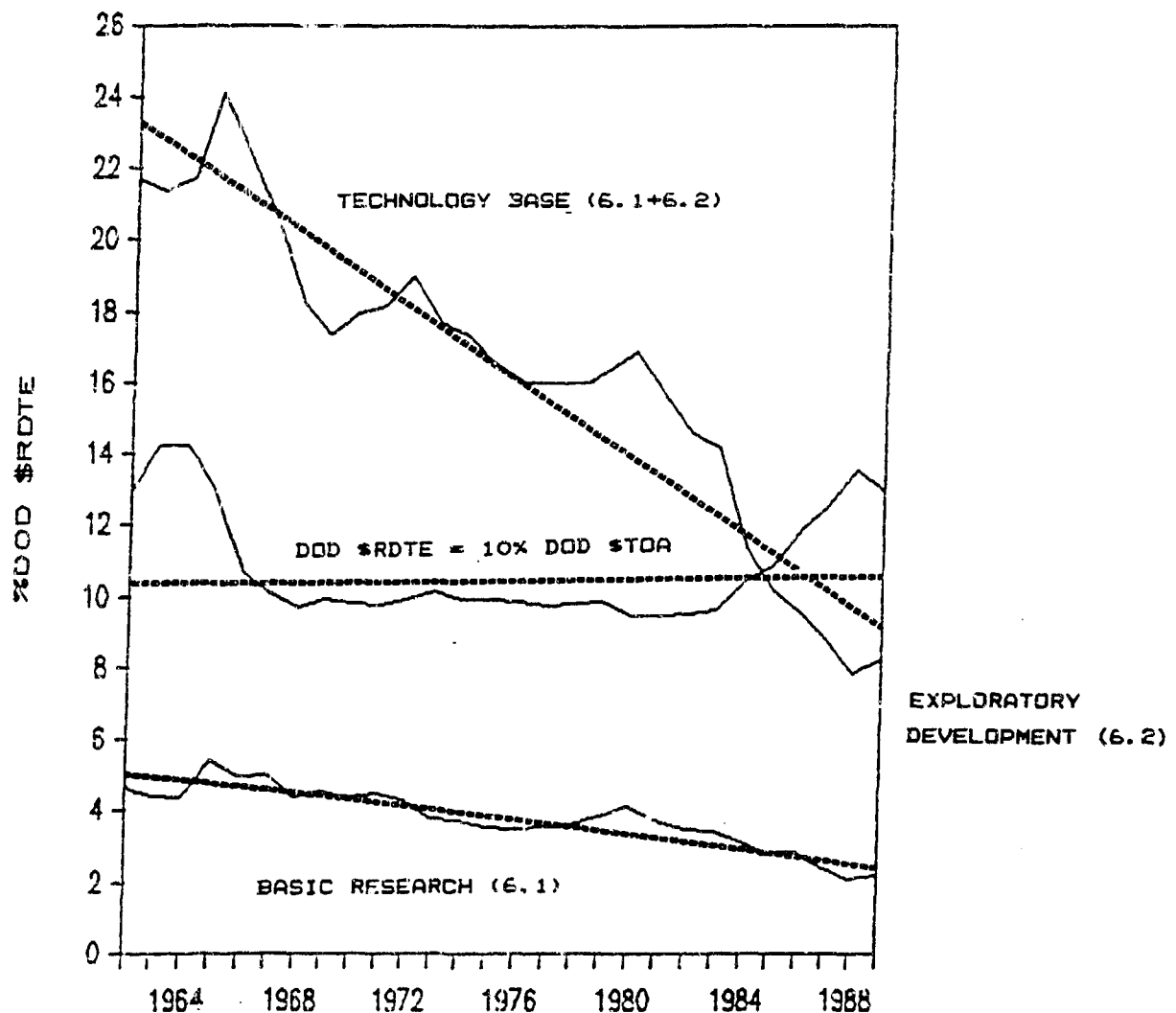
Next chart. The result is, when you adopt these sort of arbitrary budgetary rules, like fixing the top share, you wind up getting chronic under investment in those accounts-- the fast money accounts where the costs are reasonably certain but the benefits are wildly uncertain. Sometimes it's known in the commercial sector as the problem of patient capital. It was known, as a matter of fact, during the second world war. Vanifer Bush even gave it a law. He said applied research drives out pure. And that's essentially what's been going on for an extended period of time. We have been progressively under investing in military science and technology in general and the technology base accounts in particular, 6/1, 6/2.

When I'd gone through some of these numbers with my colleagues in some of the commission work that I referred to, their reaction was--we always thought the world was round. I mean, surely you must have made a mistake. You must have left some numbers out. Maybe it's the black programs, or the IRAD accounts, or some other things. Let me assure you that when you put in all those numbers, the absolute values change but the slopes do not change. The principles are essentially the same. So what we have now, is a system in which it is very, very difficult to persuade the people who control the investment accounts what the expected benefits are downstream. And I mean well downstream. The gestation peri   for most of these projects are well beyond the planning horizon of the current PPBS system, nominally 6 years, and well beyond the physical lifetime of a lot of the weapon systems in the inventory. What has happened therefore, over time, is not only that you have this chronic investment, but this idea has gotten hold in the system that the purpose of research and development, the purpose of the RDT&E account is to service the acquisition account. Acquisition goes down, it is only natural, it is only fitting the RDT&E account ought to go down. I was brought up in the business believing the reason you do research and development is because you're uncertain and you want to buy information. If you're not uncertain, it's not research and development. I don't know what you call it but that's not what it is. So this idea that you undertake R&D to buy an option, to get a hedge, has essentially been almost totally beaten out of the system over the years.

There is also this belief that because R&D is important in a commercial sense, and some of these technologies are dual use, it's OK for the department's investment a l the technology base to go down because somehow the private sector will pick it up. This leads, in my view, in an implicit belief in a free lunch. That somehow, the departments investments can go down, but we can still maintain the relative rate of technical progress embodied in fielded forces, necessary to meet our future requirements. And that raises, in my mind, a long term serious problem of how we can expect to maintain the qualitative superiority of our forces in the future.

So much for the problem, what about the possible s 'utions? We plainly would like to be able to train the way we want to fight. That is. to fight the future. And we'd like to be able to have the ability to discover new tactics to drive those technologies. This is hardly a new insight, the Packard Commission pointed out the problem in their repc t on the weapon system acquisition process, and also the Defense Science Board, particularly in their work on the 1987 report on the application of computers in training and wargaming, and the summer study last year and this year on the R&D investment strategy for the future

has pointed out the problem. The 1989 Defense Management Review, that Secretary Cheney did for the President pointed out those problems.

We still have the problem of beating down the time we have technology in the lab and getting it into the field. When you look a little more closely at the acquisition process and the proposed reforms, we still run into this problem, that training is very much an afterthought in this process. It comes after the system has been essentially, I don't want to say developed, but you're well past milestone 0 and milestone 1. And there is no model test model trained experiment, try it out, experiment with it, see what you like, what you don't like and come back to us. That flexibility has essentially been beaten out of the process. I don't know who did it, but I think we ought to find him. The problem we have is that what we'd really like to be able to do is to fight before we fly and before we buy. Now the problem is, how are we going to do that?

As has already been mentioned, the state of the art in simulation technology, at least as it's been explained to me, is just not mature enough. We don't have enough, we can't represent enough objects on the battlefield at this point, there's serious questions about how to integrate sensors, how to lash up large networks of widely separated sites, and there are problems of how to represent, for example, the dirty battlefields that we might confront in the future and that we almost confronted in Desert Storm. We can proceed in at least two steps, first, to do as much as we can to develop simulation technology to help current forces, current work, current tactics, and current problems and continue to grow the technology to the point where we can fight future forces on future battlefields. That raises, from a policy point of view, a much more difficult question. What forces, and what battlefields?

Next chart. Well, let me assume for the sake of the argument, that the basis of sand problem, that Paul Davis has written about, has been solved. I think it's too important not to be. But we also assume that the technology has been developed so that anyone can fight anyone with anything, anywhere, anytime. Beyond that we have developed a capability on the acquisition side of the house to integrate the design and manufacturing teams so that we have, essentially, an integrated process of doing continuous electronic prototype. Well, what would we do with it? In my mind, the answer is actually very simple. What you would do is create a defense futures market. The data that you have heard the early panelists discuss represents a way of doing what economists call shadow pricing. And that sort of pricing is absolutely critical to valuing R&D options in a way that we now simply do not do. The result is, since we have enormous difficulty in doing it, we resort to

heuristics like arbitrary budget shares. Moreover, if we can develop such a network, it would also give us the capability of continuous military innovation.

DARPA — What's Next?

Assume Technology Exists To:

- Recreate Any Battle - Past, Present, Future
- Anyone Can Fight Anyone With Anything, Anywhere, Any Time
- "Instantaneous" Integrated Design-Production Teams for Continuous, Electronic Prototyping

So What?

- Create a Market For Defense Futures

  -- Use Networked Simulations to Estimate "Shadow Prices" for R&D Options

  -- End "Gosplan" Approach to R&D Requirements Planning and Investment

  -- Continuous Military Innovation

There are some milestones along the road to that dream, and a couple of them that we see are: first, we would like to be able to drive on low cost training simulators, large numbers of them. You have already heard mentioned, wiring up the existing facilities in the southwest United States. I thought it was a good idea the first time I heard it, and the more I hear it the better it gets. We're also interested in pushing the problem of electronic sandtables. The last one is actually my view from the more difficult ones. And that's the acquisition process. It won't come as a surprise to anybody that DARPA does not practice what it preaches. But that too will change.

DARPA

Why Not?

- Fields

- Herzfeld

- Gorbachev

- Reis?

Training/Simulation "Unsexy" -
SECDEF Cheney

Next chart. What are some of the problems in implementing all of this? Yes, MISHA good help is hard to find. The problems, the horizons over which these kinds of initiatives will be undertaken are typically long compared to the dwell time of senior officials. This is such a serious problem that Secretary Cheney even addressed it in a speech that was not widely reported. He noted for example that it was the O&M account where the NTC, the desert flags, in short the training facilities that gave our people the kind of capabilities to do the fantastic job that they did, that's where those accounts are funded. That's where the simulators were funded. It's a totally unsexy problem in his word. To paraphrase the long statement on his part, "Nobody ever lost an election by cutting the O&M budget." Well, I can assure you, presuming to speak for Dr. Reis and others and myself, that's going to change, if we have anything to say about it.

DARPA — Constants In The New World Order

- "Only The Dead Have Seen The End of War."

- "The More We Sweat In Peace, The Less We Bleed In War."

- "The Quest For Excellence" In Military Innovation Is <u>Not</u> Over.

Last chart. You will also hear a lot, I'm sure in the next coming weeks and months as a result of what's going on in the Soviet Union and the new defense strategy. But let me just leave you with one thought and it was a thought that General Schwarzkopf echoed in one of his final speeches; it is still the case that the more we sweat in peace, the less we bleed in war. And we need all the help we can get to make sure that these guys in uniform sweat. Thank you.

McBRIDE: I'd like to open the symposium for questions and provocations among. If you'll identify the addressee...

GARVEY: In this case I would really like to make a couple of provocations and I won't address them to any one individual on the panel but rather to any one who wants to respond. The first one goes back to many symposiums and workshops held by the Military Operations Research Society in 1986, 1987, and 1988 with some very senior DoD officials present, such as the Chief Scientist in Air Force Studies and Analysis and the Director of the Army Concepts Analysis Agency, that concluded virtually unanimously the biggest problem we have in models and simulations is the lack of representation of human behavior and human performance. We have tried, I think fairly unsuccessfully, to represent human behavior and human performance in automated models. We now have a model where we actually put the human in the loop to behave and perform and there are still parts of the community that are sort of crying in anguish, "Wait a minute, we can't deal with this uncontrolled variable" and "Oh, by the way we have to do a thousand iterations in order to have statistical validity." So my first statement is to say, I would just submit, we ought to be thinking that perhaps three or four samples from the right distribution are better than a thousand from the wrong distribution. The second point has to do with the application of the technology in operational tests and evaluation and I would like to suggest that picking up on the statement that General Welch made yesterday, about our half live tests, that with this technology we can do a little bit more than plan tests and do a little bit more than interpolate or extrapolate from test results, but rather we can actually do part of the test and perhaps turn our half live test into a test that is 80 or 85 percent live. By investigating those areas that we are prohibited from doing in the half live test either for environmental reasons or safety reasons. Thank you.

A: (McBRIDE) I'll give an initial response and then other panelists may choose to do the same. Lest you think that what Dick said is unimportant, I want to bring some experience to the table that we've had where we in fact did introduce human beings. And, lest you think that the human contribution, behavior, is trivial, I bring these facts or these considerations again on the table. Our experience, specifically in testing new weapons systems where humans were manned up, demonstrated very, very clearly that in the beginning of the test, expected outcomes portrayed themselves. That is, if we had a new idea for a new weapon system, sure enough, in the beginning, that weapon expressed itself pretty much as well as we predicted But, because we had human beings--through our warfare experts--manning up that theoretical new device and simulation, and we had human

beings who were manned up in the target devices, over a period of time, we discovered that the offensive, or the capability that we've introduced, began to lose its edge because counter tactics were developed. And in fact, in a way that we never would have predicted. In particular cases, it took six weeks worth of trial and effort until the advantage which initially was going this way, soon began to go that way, and this way and that until finally it damped out and it was ultimately clear to everyone on the battlefield what the contribution this new weapon system might have. All the modeling in the world would never have derived these very brilliant counter tactics and counter counter tactics. The key here is the behavior. We enabled that weapon system, its sensors as best as could be described by analysts and the engineers who were designing and we made it work. We said alright, this thing is going to work as you have required it, as if an OR on the battlefield, and we'll let these human beings play it out. In the end I would dare you to argue with one of these men in uniform who developed the tactics and the abilities with this new weapon system on the battlefield and not only do you have proponents but you have pure understanding of how to use that weapon on the battlefield. No model would have done that, I am not denigrating models, I think then now you have your human performance, how you are going to use this model that's an input to the larger modelling at a campaign or theater level, now you have real data, now you have real distributions. Other panelists...

A: (BRONOWITZ) Although it wasn't addressed at me, let me take a shot at this. Certainly, we want to take samples from the right distribution, not the wrong one, but we want to know whether we're examining likely events or unlikely ones. You know that as well as I do, and you're saying things to provoke me, but I'll respond anyway. There's a balance. I'm not saying we shouldn't develop such systems; we just have to be careful of the way that we approach where we're going. In particular, in sequences of operations there are typically thresholds, critical points. And in any given run through the problem, you're going to go on one of these paths and get a certain outcome. It's not clear how likely that outcome is, *a priori*. In the example Dennis talked about, they examined many cases. They didn't take three or four points; they took a lot of points. And I think that's the key to what I was saying. We have to take a lot of points, not just a few.

Q: I'd like to continue this discussion. I yield to no one, my respect and admiration for many of the panel members that I know, and I must assume that the balance of the panel are equally fine folks and good scholars. But I'm disappointed, very disappointed. But before I go into a little more detail on that, a little side comment to Dr. Bronowitz. Even if Dr. Bronowitz had not been introduced as being associated with

the Navy, we would have been able to determine that from his talk. If Dr. Bronowitz had been advising Elizabeth I, in the 16th century, my guess is that we'd still be using longbows. Now, my disappointment, the word behavior was used to describe this panel. And what we heard in the main was a discussion of engineering of things behaving. Jesse talked about improving our understanding of hit and kill probabilities. I grant you that's great, clearly we need to do a better job on that. I was vastly disappointed when Ed got up and spoke. I would have thought the one person on the panel that would have addressed human behavior on the battlefield and what we might do with this burgeoning revolution that we've got here, I thought it would have been Ed. Suggestion, there's a vast amount of data about the people that fought in the 2nd ACR that's not in the data system. What's in the data system is basically engineering data. Most of you guys are engineers. You may be mathematicians, statisticians, operations analysts, but you all talk the same language. The one that doesn't talk the same language should have been Ed, but I think something's happened to him over the last few years. It seems to me that you have an opportunity with this re-creation now, let's not talk about it as a simulation, this re-creation, the way it was spoken of yesterday, one could look beyond just the training information, I know Jim commented that one approach might be to examine how these units were trained, how the troops were trained and look for some kinds of relationship between the training and their performance. You can go further than that. You've got a lot of data on these people, these soldiers. We know a lot about those soldiers, we know who they were, we know who was in each tank, who was in each APC. Why not try some rather simple regression techniques, and see if you can play with those human data, those human factors. All the great captains have told us for generations, of the relationship between the human and the material on the battlefield. I'm not sure that Napoleon was right quantitatively, but I think that he was right qualitatively. The human makes the difference on the battlefield, it's not gadgets, it's not things. The human makes the difference. As we go into the new arena of warfare, many of us believe, setting aside Europe now, some people are still worried about a grand battle in Europe, but setting that aside, future conflict for the U.S., particularly for the U.S. Army and the Marines is going to be small unit operations where people are going to dominate and we've got to be able to use the tools we now have to get the best guesses we can get. We don't need 100 percent data, we don't need 100 percent distributions, we need some clue as to the relationship of the behavior of the troops to the battle. Thank you.

McBRIDE: I would like to declare you a part of this panel. And I would suggest that Dr. Johnson might want to talk.

A: (JOHNSON) A number of phrases come to mind to describe Dennis. In terms of the question you raised, though, I'd like to make three points, if you view the data collected for 73 Easting only as an attempt to analyze human behavior in battle, I think you've missed the point of the methodology. There are a number of efforts looking at the relationship between personnel and performance in Desert Storm. We, in fact, do have a lot of data down to individuals in terms of their performance, in relationship to personnel characteristics, I mentioned one, which was the quality dimension, but also training. What we've found so far in our preliminary analyses is really not surprising. One of the surprises about human behavior is how invariant some relationships are, such as bright people do things better. What we have found is that bright soldiers fight better. You get more first round hits, they fire faster, and there are no surprises so far in that data. The second point though is if you look, the reason I focused on the training aspect of 73 Easting and this particular methodology, is it seems to me that a crucial aspect that you gain with this methodology and including an actual battle is the ability to motivate the participant who's using this. It's not just a tool to discover relationships of human behavior to battle outcomes, it's a tool to teach those relationships implicitly to other people. In terms of how you would include these in models, one of the difficulties becomes people are in fact viewed for soldiers, as uncontrolled variation. One of the reasons, I believe for the interest in man in the loop simulations, in the acquisition process, and in others is the fact that the way to account for that variation is to include people in the process. There are lots of aspects of people which may not be relevant for a given decision, there are others which certainly can be taken into account. If you went through some of the examples Jesse mentioned this morning, some we heard on the first day from General Funk and others, of the behavior of troops, it's difficult to imagine how you would predict individual performance from what we know about them in that complex environment. I think the issue that was mentioned earlier that MORS has been wrestling with of how to include humans in part is a conceptual issue of the level of analysis and what level of aggregation do you wish to talk about soldier performance. At an item level, we can do very well, at a unit level we do less well, small units, in larger units we don't do well at all. But at the small unit we've begun to get much better. The relationship, for example, between quality of soldiers, leadership style, and performance, seems to hold over a wide range, there are similar relationships with issues such as cohesion, issues of training and others. How to include those in models is not necessarily straightforward. But I'm not sure that you should say the panel hasn't discussed it. I think that part of what we discussed was the precursor or the necessary ingredients to doing that. For example, if

you recall one of the charts I mentioned, which was a task list of how you would examine the process required to plan, prepare and execute a battle plan. That data is available and on a wide number of units at the National Training Center which in aggregate, would say, here's the things that people do well, not so well, and how well. Those could be used in models now, if there were interest.

A: (ORLANSKY) An interesting interplay is going on here. We're talking about a couple of revolutions and one, not to be overlooked, is that an engineer is talking about psychological events and a psychologist is talking about engineering events. Maybe that will help both of us. That's point number one. It suggests that the community at this workshop is trying to work a problem, rather than resort to different professional backgrounds. I take that as a compliment. The second point comes directly from my background. The historical effectiveness of psychologists working for the military forces has been at the individual level. Starting in World War I, psychologists began to work on problems of testing, selection and assignment of individuals. However, our ability to use individual data to predict what happens in group performance is very poor. The use of individual data, whatever its worth, is limited largely to predicting how well individuals will succeed in schools and, significantly less well, on the jobs for which they have been trained. However, war is only incidentally about the behavior of individuals. Success in battle requires the coordinated and cooperative behavior of many large groups of people. The second revolution, which must be understood, is that SIMNET gives us virtually the first capability we've ever had to observe the performance of large numbers of people working as crews, groups, and units. We've never been able to do that well before the arrival of SIMNET. In my opinion, we've gone about as far as we can go in our research on how well individuals learn and work as individuals. Now, we have the first opportunity ever available to examine group performance. Using SIMNET as a prototype, we can get data on how tank platoons and larger units operate as forces in combat, support each other and coordinate their firing opportunities. The basic resulting data does not require us to ask who did well, who did poorly, how a participant was educated, and whether he was smart or dumb. For the first time ever, we have an opportunity to measure how well large groups of people operate at all echelons observable in the SIMNET paradigm, similar to what actually happened in 73 Easting.

I think your comments are well meant but they're so wrong they're not even funny. In trying to apply to 73 Easting a technology based upon our professional expertise about individual behavior, we'd simply be fighting the wrong problem, such as trying to predict

performance in battle based on an intelligence test or performance in school. We now can, for the first time, examine group performance at the group level. And the thing not to miss about SIMNET and 73 Easting is that we now have the behavioral tool to examine the performance of large groups of people, in tank platoons, or on an aircraft carrier, and we no longer need to concentrate on how they were educated. Now, we can examine group dynamics and how groups help each other or in combat environments, both simulated and real. Some of the early work at RAND and SDC on air defense control was most interesting in this regard. Air controllers were trained to direct friendly aircraft to intercept attacking enemy aircraft in a simulated air defense direction center. About 30 controllers in each test had to handle hostile raids of about 100 aircraft. One of the first lessons learned was that feedback of performance had a very significant effect on improving the group's performance in vectoring friendly aircraft to intercept hostile aircraft. Members of these groups learned to compensate for the limitations of other members of the group. They learned about each other's idiosyncrasies. Given knowledge of the outcome, if someone did his job poorly, the rest of the group was able to make up for the difference. Fascinating stuff; when groups of people operate together and have some knowledge of their effectiveness as a group, they tend to help each other. That is one of the essential combat lessons of 73 Easting. Now, with distributed simulation, we have the technical capability to understand the way in which large groups work, how groups help each other, what the significance of the leader is, what the significance of the output is, how the crews correctly or incorrectly use the feedback available to them and that's the area where the problem exists and we're now able to work this problem.

McBRIDE: A quick example of what Jesse is saying and then I want to turn it over to Paul. What you saw was a list of variables, a list of metrics, one example of which was opportunities to fire or be fired upon. The next level of questions, once you have this level of understanding of that sort of information, is how did these opportunities occur? Some were due to chance, but some were created. At an aggregate level, at a team level, how did these opportunities get created. That to me is behavior. It's a reflective analysis of how we actually worked on the battlefield that resulted in tactical behavior. Paul ..

KOZEMCHAK: There's an old Abbott and Costello episode in which Lou manages to find himself locked up with this crazed criminal who goes berserk at every mention of the word Niagara Falls. And, of course, you recall in the episode, every minute or so, Niagara Falls comes up in the conversation. It's your misfortune that I feel the same way about long bow, and the 18th century English army. I actually happen to know

something about that subject. It's as result of having studied with Morris Janiwitz and Bill McNeil, distinguished professor of History and Sociology at the University of Chicago. It's because of that that I rush to construct a hasty and imperfect defense of Dr. Bronowitz. It turns out, when you look at the views of those individuals and their assessment of why did the 16th century English army dump the long bow and go to the muskets. The argument is, on sort of a round-per-round basis, the bow out-ranges the gun, and it's more accurate and everything else. And so you do these side-by-side comparisons, that we've all been accustomed to over the years, and you say, plainly we're missing something here. What they were missing was a simple fact that related to the economics of training. The British Treasury did not have to pay to develop the muscle skills in the hand. That was a free good that came to the British Treasury as a result of the dual use of also using long bows for hunting. As a result, what happened, you can go back, there's an excellent piece in the *Journal of Technology and Culture*, which if anyone is interested in this area, it's manadatory reading, on that whole transition strategy. And it really did revolve around the problem of not having the right model of the modernization, cost to modernize and cost to train in the British Army at the time. It was a blind sight that was peculiar to having just looked at the individual decisions that were made and not put them in the right financial context. You want to have an Army so long, so big and so proficient, and has these following kinds of skills, it's very much like General Welch's four pillars, how much do I do on modernization, how much goes into training, and how big or how small can it be. So you really do have to have, in some sense, look at the right models of the problems. Yes, at one level you have to take into account of the individuals. Here's one from the point of view of the historical profession that traditionally over the years has not been done.

Questions:

DUPUY: I'd like to preface a few general remarks which are to all of the panel with a statement of my first perception and concern about SIMNET when I met it a little over a year ago. We had here a very seductive appearance of reality without any assurance that it was real. That concerned me and has concerned me up until this meeting. I think that Jesse Orlansky both overstates and understates the significance of this exercise that has caused us to be assembled here for this conference. The drama of the interaction of history and technology is certainly clear and its new and unique and I had a chance to say a word or two about that yesterday. But most of the data has always been there...

There will never be resources available to do anything like the effort that was made in 73 Easting that has been portrayed to us in the last couple of days. There may be one or two other efforts, I suspect there will never be another effort like this, devoting the resources of funds and people to recreation of a relatively small, and despite its drama and interest, relatively minor historical incident. Furthermore, here I agree completely with what Dr. Bronowitz said, we can't tell how valid the lessons are that we get from 73 Easting, that is one incident and I can show so many different examples, historical examples, that are wonderful to make a point, but are totally inconsistent with the general patterns and trends of history. So I would be most reluctant to take 73 Easting as the truth of history. It is true, but it is not necessarily consistent with the best truth. We must have many, many more before we can say what the lessons are that have been learned from this.

Now, what is to me significant, from the reason why we're here, is that technology offers us an opportunity to help to apply comparable rigor to the generally available data. In other words, once we are reasonably satisfied that SIMNET is at least close to reality, we can do what was done by Gary Bloedorn, Mike Krause and others in the last few months and test whether what we have learned, what is written in history, what people have said, is really true or not. In a way we've got a mechanical del brook here. An opportunity to test the reality of history. Once we have calibrated SIMNET to approximate historical data and obviously we are approaching that with what we've gotten in 73 Easting, we can use it to apply to a lot of historical data. Now, what this gives us is the possibility of more reliable, tested data in files and available for analysis. Better evaluation of models by data, better evaluation of SIMNET in an interactive iterative process, an opportunity, people have been mentioning NTC data and I'm always concerned about NTC data because it isn't real war, despite the stress and strains and drama of the exercise. People know that they'll be going home that evening and getting a warm, good meal and sleeping in a relatively warm bed. So this gives us an opportunity, in my opinion, to calibrate NTC results with history. And relative to a couple of things that Dr. Johnson said, it gives us an opportunity to understand the battlefield better, I believe that. And it gives us an opportunity to motivate in ways that weren't available to us before to make history something not just for its own sake, but something useful for training and education in the military art. So I am encouraged by what I have seen and I see an opportunity to resolve my early concern with SIMNET. Thank You.

Any responses?

Q: They say that half the value of these conferences is what happens on the break and there I was talking with one of Dr. Johnson's protégés or colleagues who said, "You know Capt. McMaster and his two fellow troop commanders were academy classmates, in fact, two of them were roommates." Knowing one another for four years of undergraduate military training plus their junior officership and then being on the same battlefield, may or may not have ensured a degree of communication and understanding of one another's cognitive style that had as much to do with the outcome as any other variable you've thrown out. So I think it is important that we look at behavior from the standpoint of both the individual and the relationship to track what Dr. Orlansky said, the relationship of what those individuals do interactively in order to produce leader behavior and team behavior. And I'd like to address any response to Dr. Johnson.

A: (JOHNSON) I'm not sure it needs much response. I think one of the advantages of this kind of a simulation in terms of team and leader behavior, is that it allows you, for example, to look at what's happening at different levels of the organization. One of the problems many leaders have is when they issue an order, understanding what that order means at the bottom of the organization or at other levels of the organization. How well have they communicated the intent of the order? There are a number of graphic analogies people have used over time, one that I'm reminded of is the General at Fort Hood who once said "the building looks like it needs to be cleaned up." Two weeks later all the buildings in the area were painted white. By the time, "the building needs to be cleaned" got down to the person to do the action, it became, "paint the damned buildings, quickly, before he comes back." This kind of technique though offers an ability for leaders to do that, it also offers an ability to look at communication patterns. We've only looked at this as a tool that one participant could enter to look at the battle. Multiple participants can enter and there's no reason that only one person has to poke it to see what wiggles. Different people could poke it to see what wiggles and whether the same thing wiggles. So I think it's really an invaluable tool to get at issues of cohesion and team performance, which I think are really at the heart of a lot of conflict.

McBRIDE: I'd like to make two quick comments. One relative to the training value and the other relative to inferencing and R&D systems acquisition. First, in training, I think of two things constantly. The motivating fact is that, if you had nothing else but to have captured real history, real war, and you were able to insert human beings into simulators passively to ride through what happened, I can just imagine that would be one hell of an inspiring ride through history and a way to motivate and inspire young eager to

learn kids. But, I think more importantly, let's assume that in the future there's some way to institutionalize 73 Easting, such that automatically, as war unfolds, it records itself into some container and this container then inserts its information into the system and 73 Easting is automatically rendered. The consequences of that would be that, if I know that and I'm in a tank, I know the future that my behavior is going to be unfolded in front of all to see, I suspect that it would guide my behavior in ways. It may stretch my envelope of daring, it may restrict it, but I think it has serious implications for how we teach and how we expect human beings to behave in war. The second perspective is the business of inferencing. By putting together the simulation by allowing it to play itself out as it really was or as we think it was, I think one of the most valuable things that we can do is to reverse engineer what must have been the red commander's intent. By examining all the raw data, by arresting documents that indicate Soviet or red or orange or whatever the hell color it is this week (bad guy doctrine or tactics), I don't really know anything until I can understand his thinking process and what must have been his intent. And I think of this captured technology as a way to reverse engineer and understand how a commander must have been thinking.

ORLANSKY: In 73 Easting, we probably ha _ _ne most thoroughly and most accurately documented case of actual combat. I dare say that if, by magic, the same troops on both sides were back there again, the battle would not work out in the same way, for a whole bunch of reasons. Although we have captured this one, very important case, it still is just one case and, as such, has limited statistical or predictive interest. But it does happen to be damn, damn real. The issue that we face, then, is how to use that single case of rarely available, invaluable information. I think here's where we have to be a little imaginative. We have to replicate cases like that, at the National Training Center and in SIMNET, to provide data on statistical variability that we can't get in real life. This will not make 73 Easting more valid, but it will give us a better understanding of the range of events and the ways in which the critical aspects might influence the results. I would want a young officer to know about all those possibilities so that when he faces real combat and it doesn't go exactly the way for which he prepared, he can better think through what his options are.

At the present time, we can chart a path between the need to use very precise information about one unusual, real battle and being able to think how a wider range of events, that were not in 73 Easting, could significantly affect the outcome of a battle.

STEEB: I'd like to recount one incident at Rucker that seems to tie in this discussion. We've been running a number of helicopter pilots through an OH-58 simulator. One crew had experience together, having flown in Korea on previous tours. Their tactics interactions were different, typically, than crews that hadn't been together. We weren't able to replicate their performance with the other crews. Now when you're going to be evaluating a system, you have to decide whether or not this particular system is better than another system, and you will often have to script your automated forces on the basis of your manned runs. Do you try to work with the crews that have smooth interactions and experience together in the field, or do you use crews that are randomly paired. Each of these have problems with ease of recreation and generality of results. This is one of the problems we're facing there.

BLOEDORN: I'd like to share a confidence with you and step out of my role, for just a second, as the man who collected the data and also one of the people who specified the performance of the semi-automated forces. I would like to link those two with you and respond to Paul Kozemchak's excellent briefing. There was an interaction, I spent hours and days with these soldiers in the desert and back at Grafenwöhr and listened to the war stories and how they related with each other. And remember I told you as we put them in the simulation we stepped back and allowed the chain of command to refight the battle. Keep in mind, my model was what I had put in semi-automated forces on how they should have performed and what the PKs and the PHs and what were coming out of AMSA, BRL and several years of research to put into how SAFOR should fight. Now I'm listening to these young men tell me how they fought and gleaning from it why. There is an interaction, not only as Jesse has articulated extraordinarly well, of group behavior. "A" did what he did, because of what "B" did not because he was breast fed or his mother's bottle of milk. He did it because of what "B" did, and it is unique, it is history, it will not happen again, it's true. So we can study it for trends, we have to examine it and we have to examine many battles and we can only do it in simulation. The thought that I want to give to you, is they also had an interaction with their machine. These men went into battle convinced, rightly or wrongly, and it turned out rightly, that the M1 tank was the finest piece of equipment on the face of the Earth and with the A1 depleted uranium armor package and ammunition, that they were almost invulnerable. And their first combat actions reinforced their expectations. An officer of the regiment, who was on the battlefield, who was at 73 Easting, said to me this morning, "Col. Bloedorn, you know that they were bold and they did that because of their belief in their tank and their gunnery skills." It's been said to me, time after time. You've got to quantify the interaction with

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that equipment and that's material acquisition. When you look at the ergonomics of the T72, and the sequence to fire it and to acquire a target with it, and you compare it with an M1 tank...So as you go forward, and what you pick out of 73 Easting, put the machine in there, it is extraordinarly important. Thank you.

By the way, if I was designing semi-automated forces again, this kind of experience now would weigh very heavily. And I would challenge the models that I had of the M1 and the T72 much more rigorously than I had in the past

McBRIDE: Gary, you're coming out of your shell. I think one more question.

Q: I don't know if this is a comment or a question, I'm not sure I can properly articulate it. General Funk started us off the day before yesterday talking about the importance of the National Training Center and what it's done for our Army so brilliantly and I think it's important for us to ask the preliminary question—did the 2nd ACR go through the NTC any time prior to 73 Easting?

A: No. Almost all of their troops, the commanders, une sergeant level had.

GORMAN: Gary, the question was did the 2nd ACR go to the National Training Center?

BLOEDORN: Yes, sir.

GORMAN: The 2nd ACr has been on the border of West Germany prepared for an invasion of the NATO Warsaw Pact Forces.

BLOEDORN: But individually they haven't.

GORMAN: That goes to the question that this panel has been dodging, the background of these individuals.

Q: That was an initial question I had and I thank you for the answer but the second part of it is, we have something that is unique at the National Training Center, we have for the past 15 years, its been kind of hidden. Yes, it is a simulation, it's artificial, it's really the best training they possibly could have had prior to going over there. And there's two components to that training, one component is where they work against the OP 4 and the targets, to live fire exercise. But the second and very important component is the observer controllers who critique their actions. These observer controllers are masters at the game. They really know, after having been through X numbers and 20 years experience, they know what has to be critiqued. And that critique is probably better remembered than the actions themselves. They remember the very brutal honesty of these

controllers that tell them, "That was stupid, why didn't you control your scouts, you lost total control of your scouts." There, in front of God and country, in front of the Generals, in front of the brigade commanders, a battalion commander sits and receives this brutal critique. And yet we have somehow been able to absorb this into our system, that has, for so many years in the Army, been relied on dishonest OERs. I'm not saying they are all dishonest, but many of them are inflated. On inflated radiance reports and we all know that radiance reports haven't been the best. But nonetheless, we have been able to institute something quite different out of the National Training Center than we expected. It's a new ethic of honesty and brutal honesty in critiquing these actions. Now, trying to transpose this to what we've seen here in advanced distributed simulations and technologies, we see 73 Easting, which is a wonderful exercise and a tremendous effort. I think everyone applauds the simulation and the development of this work that's been done to date. What I don't see is how we work in the critique. How do we develop that critique? Dr. Johnson had a wonderful list of how we evaluate all these things that we do at National Training Center and we put them into nice little blocks. But for training purposes, and we run these advanced simulations and distributed simulations, how do we make sure that we have the right critiques given to these people that play these games, I don't mean games in the usual sense. But how do we make sure that they take away the right things, and not take away the attitude, well here we are with another Nintendo game, so what, let's play again, I may have lost that time, maybe next time I win. We want much more out of this and I think the second element, this critical critique is missing so far. I want to hear more about it.

A: (McBRIDE) I'll take the first shot at it. The basic idea is that the solution is embodied in a notion called command. That is, in this environment, there are no referees, there are no judges. The only evaluator of your performance is your senior officer, and of his, his senior officer. So the representation is that we're really at war. It's just that we're using simulators and we'll debrief as we would if we were in a warfare environment. That's a simple level answer. Now if that's been institutionalized and made out as a critique, I'm not sure that we're there. Other comments.

A: (JOHNSON) To answer part of it, the critique, or what's at the National Training Center called the after action review, is a somewhat institutionalized process at many levels of training. You just mentioned, in part, it's a commander's prerogative. A lot of distributed training systems in SIMNET in particular, with the exception of a few particular applications, we're still in the process of developing the kind of after action review and the procedures that go along with it. If you look at how SIMNET was brought

into the Army, it was brought in from the top down, not from the bottom up. There's a nice article in this month's issue of "Human Factors" which describes the history of SIMNET and I think if you look at that you'll have an idea of why a lot of the training management and training procedures that go along with it, as well as, for example, the data collection procedures to provide the feedback. When you mention the after-action review at NTC, what's driven a lot of the data collection, is the need to provide feedback to the unit commander and to the participants about how well they've done and why they've done the way they have. A lot of that has not been developed in a way that's easy to use out of SIMNET.

One quick question, and we're going to close down.

Q: (LOFTIN) I've been a trainer for a number of years in both peace and war and when I came to this conference I thought it was about training and learning some things, so I came here to do I guess a lot of listening. One of the things I heard early on was this is some new technology and this is work in process. This is not a final report and we don't know all the answers. I guess I'm disappointed in what I perceive to be a lot of criticism for something we have had laid out in front of us and said this is an opportunity, some new technology, it's an opportunity to do new and innovative things that we've never done before. And in that context, how can we as people that are part of both government and industry learn, apply, modify, study, and help us all understand the art of war and what things we must do indeed, to help young soldiers, sailors, airmen and Marines to fight and win in future battles. So I guess maybe, as the last comment, I would say, if we approach it perhaps from more of a standpoint of how do we proceed and take the next step from here, maybe that might be a little bit more constructive way to look at it as opposed to cast rocks for people are suring with us a very quick slice of some work that's ongoing.

McBRIDE: Thank you, Dean.

Let me close this panel session, first of all, by thanking these panel members for doing an excellent job and thanking all of you for your participation and your attention. I want to make a reminder and an indication for those of you who don't know, the distributed interactive simulation standard that is an ongoing and living product based on the work of a lot of people is nearing fruition as a standard. There will be a meeting 24 September in Orlando, Florida, to again do the business of tightening up and finishing the authorship of this standard. Dr. Bruce MacDonald has detailed information. But for those of you who don't know this standard is a means by which simulators converse with each other and as well in the future these simulators will converse with each other. Lastly,

I would like to thank a lot of people for a lot of hard work, and I'm certain that Col. Thorpe is going to do the same thing. I'd like to thank Col. Thorpe and as well, some IDA people to include, Jesse, Neale, Bob, Ulf, Chris, Danet, Jill, Debbie and Georgea and Gary for a heck of a fine job. All the things that were transparent and went seamlessly here, as we say it, was due to their very, very, very hard work. I want to make sure they know we appreciate it. At this point we'll bring Colonel Thorpe back up to the podium for closing remarks.

COLONEL THORPE

Dennis told you about the interoperability standards conference. The other thing is, the guys that have been running the ODIN system and displays are going to stay through lunch in case anybody wants to get a little bit more hands on. Just go out and talk to Bob, Chris, and all the fellows that have been making this work in real time for us. There is always the risk of missing a few key people. There have been some real dynamite folks that have helped us get organized, set up, and run pretty effortlessly, and Neale Cosby and his staff have certainly been key players. Also we really have had some terrific support from the IDA graphics folks, who have done just a really dynamite job. Jill, would you come out here, please, for just a minute. In the back, climbing over a bunch of absolutely pitch black bleachers, with giant holes and stairs and steps, I mean this is a disaster ready to happen, has been Jill Avery who has been flipping our slides, who has to do it backwards, upside down. This is really a horror back there in trying to make anything happen and when you have to get them upside down and backwards, it's been just fantastic. The fellow, when I want to do something like this, and hold a conference, and I say please be the production fellow in charge of it. I never have to worry about it again, and this just all magically happens. He's sort of a master designer and architect, who lives inside my mind and whose name is Ulf Helgesson. The reason things like this go seamlessly is because he attends to the details. He's in the back, wave your hand back there, because he is just dynamite. He does a number of things. This is the first conference that I've ever had at the Radisson and I've been terrifically impressed by just how good they are. The staff has been doing the food and cokes and all that stuff. We haven't had to worry but a blink about any audio problems. The fellow that's been with us for the whole conference is Mr. James Scott. He's back there, just a kind of quiet guy, but talk about a professional, there's a young man that is really dynamite. Thank you, James. It's always a risk to take something that's still in development and use as research

equipment and stuff and try to put on any kind of a conference. So, to set up stuff, bare your soul and let people watch your electrons running around in your shorts, is always a real tough thing to do. The guys who've really pulled this together, the young scientists from BBN that have really been working on the project and guys it's just been terrific for what we've asked you to do you've really excelled 190 percent. Thank you, thank you very much for your hard work. Gen. Ben Harrison reminded me to pass on to Gen. Funk one piece of information that was unresolved. Gen. Funk, as you know, in his opening address, said that he can't exactly remember the definition between training and education. Gen. Harrison came up and made sure that Gen. Funk would never ever forget what that definition was. Gen. Harrison said "It's easy to remember, you just remember this one simple question; would you rather have your teenage daughter be the recipient of sex education or sex training?"

PURPOSE OF THIS CONFERENCE

- **Describe a technology application**

- **Share methodological lessons learned**

- **Get new ideas, critiques, mid-course suggestions**

- **Discuss problems, limitations, potential applications**

- **Discuss data sharing**

- **Help launch similar reconstructions**

This is the chart that I showed two and a half days ago when I was trying to think about the objectives of such a conference. I think that, more or less, we've been able to communicate to most folks what we had in mind when we started the project in terms of what the technology application was. The nature of this technology is always tough.

Whenever we're talking about stuff like this, no matter how careful we are, a lot of times, we don't communicate it carefully enough and folks don't always hear the words right, too. Communication doesn't always work. So if you folks don't exactly have it in terms of how you do this stuff, that's just an ongoing dialogue that we have to keep up. We tried to tell you, at least the approach we used, in terms of the methodologies. I think, especially today, we got some especially good critiques and I hope that we will continue to be the recipients of your critiques and ideas. Thus that third bullet in terms of good suggestions. I mean the one really hot suggestion that Gen. Gorman keyed on just a moment ago that several people have come up separately and also in the audience have raised, and that is this is a marvelous time to make sure we collect as much information about the people who participated here. Not so much to track those people as individuals and make sure they get promoted or not, but just to know who they were, when they went in here, etc. Because we now have a slice of their behavior and then know where they go and what they do. That's a challenge for all of us. Fellows like Gen. Paul Gorman have been beating on us for years to do that as a matter of routine and perhaps this is the time when we ought to just pick that up and carry that challenge. We sure have talked about a lot of limitations and problems, a lot of applications. We had, I think, a fairly good first session of folks who were interested in sharing and/or receiving data from us and how we might do that. We didn't get anything resolved, of course, as you would expect in a first one hour discussion while we're still trying to remember each other's names. But I think we at least have a nucleus to start to try to have. What I haven't heard yet, in any concrete sort of way, are any proposals to do other battles associated with Desert Storm. There have been a couple of proposals to do other battles, earlier, pre-Desert Storm like the Civil War and we're considering those right now. But I'm going to leave that bullet up there as, perhaps, one that hasn't been hit on quite yet, with the idea that we have to figure out as a group do we want to do that, how do we do that, should we work with whom, when, how and stuff like that.

Last night I was trying to summarize what I thought. We were sort of coming to grips and I didn't have the benefit of today's panel, so there were obviously some other excellent points that were raised. But let me try to key on these for just a moment. No. 1, I think everybody absolutely now is crystal clear on their mind, if you choose this particular medium of interactive simulation technology to try to capture some event, that medium by definition, by the way it has been constructed, by the way it's used and operated, absolutely demands that you get rid of all ambiguity. You must specify what

everybody was doing whether that's what they were doing or not. That leads you to the next real problem. When you play it back, when you reenact, when you present it, there's no clear way, yet, in my mind as to how you let the technology show those areas of the battle, of the real world event, where you were uncertain about actually what happened. If I write about it, as a documentary, a narrative, or if I show you a single chart, or a video tape, I can explain in words where the holes are. It's harder here, we haven't made any provisions yet to show that the world suddenly turns kind of green but when you get into areas where you're not exactly sure what everybody did, or a vehicle turns kind of grey, when in fact, you were guessing. So we haven't come to grips with that as a research community. It seems to me, that's something we have to grab hold of and figure out what to do. Several of you have hit upon a really key piece of research that still has to come to grips with, that is, as I leave the simple presentation of an animation that Hanna Barbera could have done and I get into an interactive system where an individual could come in and change things, just what is the mechanism by which I pass control and how do we do that, and what are all the various problems associated with that, so that the result actually is useful to somebody. We've had several people come up during the course of the conference and sort of say, I have a piece of data about this or that about this particular battle, and I think that will continue as folks know more and more about what we're trying to do and that's great. It requires us to integrate that in a comprehensive sort of way and we're willing to take that challenge. Second, the last point there is a comment that was made, we really do need to apply this construct to other examples. It came pretty strong from the panel of senior officers yesterday that it better be joint; you better take combined arms joint examples right by the horns. That's a challenge on which to expand and extend this technology. We have been talking with our close friends from the British Embassy about opportunities to look at some of the British/U.S. multi-national interactions because they clearly fought alongside, intertwined with us on some of the fronts in Desert Storm and thus one can imagine expanding from joint to multi-national as a possibility too.

As to that last point, I do need to share with you that although I kind of implied that we really didn't get a handle on that, we did do a really early exploration of another battle, one that is better aligned with the color of uniform I wear. We did get some AWACS data. We're able to monitor some transmissions of some Iraqi fighter pilots early on in the air war. What we focused on were early hour flights of four Iraqi fighters moving up into where the allied fighters were now starting to clear the skies in the move for early air superiority. We were able to monitor and translate the network traffic, voice

communications between these four pilots as they were moving in and got a pretty good translation. It turns out that the flight lead was one of Saddam Hussein's most honored fighter pilots, chosen to take the first name of his leader and so his first name was Saddam. The transcript goes as these four planes racing into the battle, and upon the sighting of the first single air force F15 coming their way was "Gee Saddam, we better do a 360 and get out of here," and, ladies and gentlemen, that was history.